Appendix B. Distribution, Life History, and Status of Relevant Species

Table of Contents

Page

Appendix B

Appendix B. Distribution, Life History, and Status of Relevant Species

This appendix summarizes important life history, distribution, stock status, and trend information needed as background for evaluating impacts of management alternatives on the affected environment of groundfish. If available, historical data on biomass and landed catch are graphed.

B.1 Groundfish

For groundfish, biomass data are taken from recent stock assessments or NMFS trawl survey data. Landing statistics are also taken from recent stock assessments, SAFE documents, or PacFIN summaries. Unless otherwise noted, a coastwide perspective in these trends was presented.

Groundfish summaries are grouped into four main headings in the following sections:

- Roundfish
- Rockfish
- Flatfish
- Other groundfish

Within each of these sections, species are listed according to their stock status:

- Overfished
- Pre-cautionary
- Above Target Level (MSY)
- Unknown Status

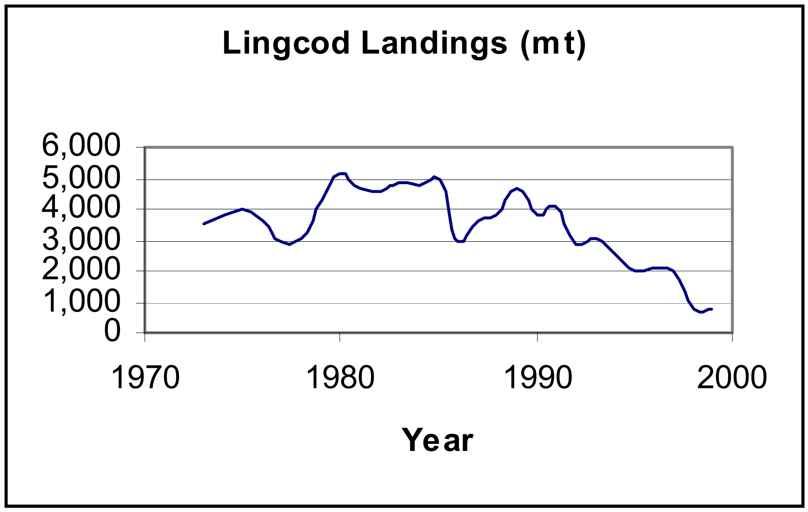
B.1.1 Roundfish

The lingcod stock has been designated as overfished. It appears to be rebuilding well.

B.1.1.1 Lingcod (*Ophiodon elongatus*) within the PFMC management area is a shelf roundfish species of the family *Hexagrammidae*. Most lingcod catch has occurred in the north in the Columbia and U.S.-Vancouver International North Pacific Fisheries Commission (INPFC) areas which is consistent with the estimated geographic center of biomass distribution occurring water off Washington and British Columbia

(Hart 1973). Lingcod were often caught in shelf trawl and recreational fisheries. Exploitation was estimated to be over the maximum fishing mortality threshold (MFMT) now used as a proxy MSY harvest rate for lingcod ($F_{45\%}$).

Lingcod are caught by nearly all gear types in bays, estuaries, and nearshore and offshore areas out to 200 fm on the continental shelf. It has a habitat preference for hard bottom and rocky high relief habitats. Lingcod was declared overfished in 1999 and the Council as developed a rebuilding plan with the goal of rebuilding sablefish to B_{MSY} in 10 years with a 60% probability (Jagielo and Hastie 2001).



Distribution and Life History Lingcod occur from Kodiak Island, Gulf of Alaska to Baja, California with the highest densities from Point Conception, California to Cape Spenser, Alaska. They are classified as an estuarine-mesobenthal species (Allen and Smith 1988).

Young lingcod larvae are demersal. Older larvae and young juveniles are epipelagic and primarily found in the upper 1.6 fm (3 m) of the water column. Off California, young juveniles are pelagic and occur in the upper 19 fm (35 m) of the water column. Juveniles move to deeper water as they grow, but are still most common in waters less than 82 fm (150 m). Adults are demersal along the continental shelf and most abundant in waters less than 109 fm (200 m) in depth. The catch of lingcod is generally highest in 38-82 fm (70-150 m) of water from Vancouver Island, British Columbia to the Columbia River estuary. Analysis of fishery and survey information show that male lingcod tend to be more abundant in shallower waters than females, and that larger fish of both sexes are found in deeper water (Jagielo 1994).

Adult lingcod prefer rocky banks on upper continental shelf.

In general, lingcod are patchily distributed among areas of hard bottom and rocky relief. Larvae are typically found in nearshore waters. Small juveniles can be found on sandy substrate in estuaries and subtidal zones all along the coast, but are more common in the northern extent of their range. Large juveniles settle to the ocean floor on sand, often near eelgrass or kelp beds. Adults prefer slopes of submerged banks with seaweed, kelp, and eelgrass beds 5-38 fm (10-70 m) below the surface and channels with swift currents flowing around rocky reefs. Adults are strongly residential, tending to remain near the reefs and rocky areas where they live (Adams and Starr 2001). Lingcod associate with other nearshore and shelf rockfish and cabezon which demonstrate similar habitat preferences.

Lingcod lay eggs in a nest which is guarded by the male.

Spawning lingcod are generally associated with nearshore, rocky reef habitat. During spawning, male and female lingcod gather along rocky reefs affected by strong wave action or tidal currents (Vincent-Lang 1994). Egg masses are usually found in rock crevices or under over hanging boulders and have been found to depths of 53 fm (97 m)(Karpov *et al.* 1995). As current flow is necessary for gas exchange, eggs are usually laid in areas with currents 3.5 km/h or greater. Male lingcod guard egg masses from predators during incubation, removal of the male results in a high incidence of egg loss (Karpov *et al.* 1995). Spawning adults and eggs are common in Puget Sound, Hood Canal, and Skagit Bay, Washington and in Humboldt Bay, California (PFMC 2002d).

Stock Status and Trends Coastwide commercial landings peaked in 1983 at 4,146 mt. Historically, trawl gear made up the majority of landings coastwide (76%). In 1999, trawl gear comprised 63% of the commercial total for the northern coast (US Vancouver and Columbia areas) and 50% of the total for the southern coast (Eureka, Monterey, and Conception areas). Historically, recreational landings comprised a larger proportion of the total landings for the southern area, compared to the northern area. In recent years, the recreational portion of the total landings has increased in the north. The 1995-99 average proportional recreational was 49% of the total weight in the south and 21% in the north.

Jagielo *et al.* (1997) estimated the abundance of the northern lingcod stock in the Columbia and U.S.-Vancouver INPFC areas to be at 8.8% of its estimated unfished spawning potential. Therefore, the National Marine Fisheries Service (NMFS) declared the stock overfished in March 1999. Jagielo *et al.*

(2000) estimated a coastwide biomass of lingcod to be at 15% of its unfished biomass, confirming the need to rebuild the stock coastwide. The most recent assessment applies to lingcod in the full PFMC management zone (the US-Vancouver, Columbia, Eureka, Monterey, and Conception INPFC areas. Separate assessment models were constructed to describe population trends in the northern (LCN: US-Vancouver, Columbia) and southern (LCS: Eureka, Monterey, Conception) areas.

Recruitment in both northern and southern areas has been low in recent years compared to recruitment before the 1990s.

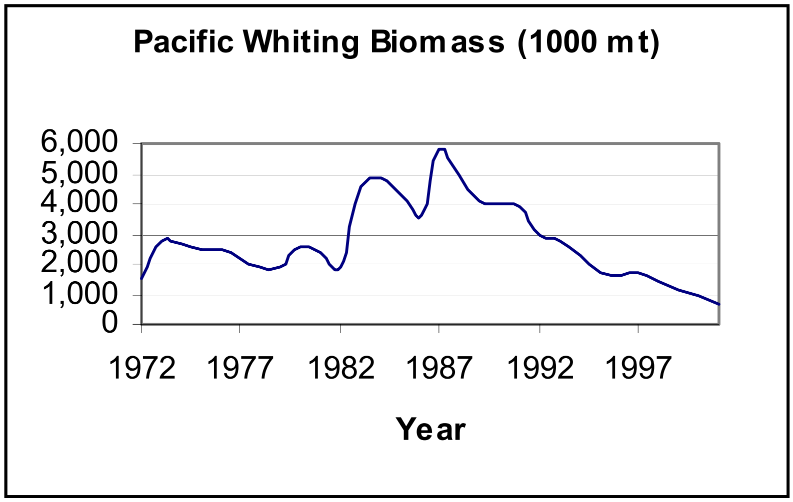
Total stock biomass (age2+) in the northern area declined from over 27,000 mt in the mid 1970s to approximately 6,500 mt in the mid-1990s. Estimates of recent biomass indicate an increase to approximately 8,900 mt in the northern area. In the southern area, total biomass declined from over 14,000 mt in the mid 1990s to approximately 5,700 mt in the late-1990s. Estimates of recent biomass indicate an increase to approximately 6,200 mt in the southern area. Female spawning biomass (SSB) in 2000 was estimated at 3,527 mt for the northern area, and 3,220 mt for the southern area. In both regions, recent recruitments during the 1990s have been low compared to the early part of the time series (1973-82). Estimates of female unfished spawning stock size (B_0), derived using historical recruitment averaged over 1973-82 were 31,033 mt for the northern area, and 22,800 mt for the southern area, respectively. Using these values, female spawning stock size in 2000 was 11% of the unfished stock size in the north, and 14% in the south (Jagielo *et al.* 2000).

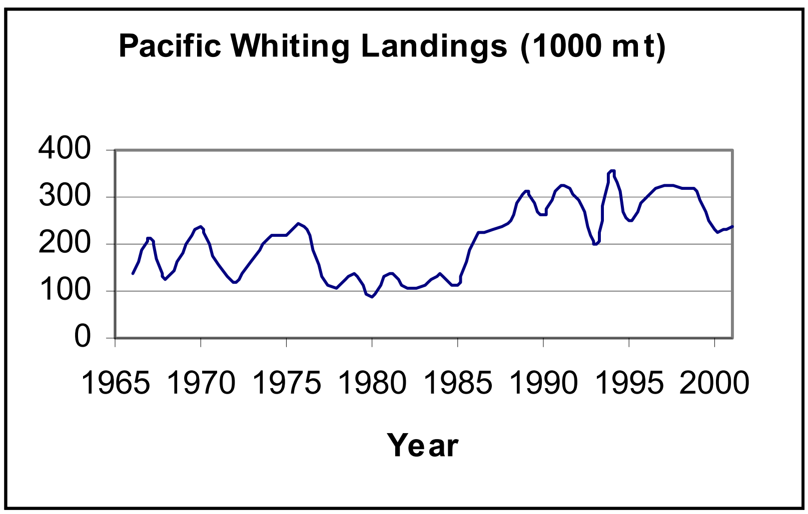
The southern stock appears to be relatively more abundant than the northern stock, but the southern assessment is based on less information.

Major uncertainties within the stock assessments are associated with differences in stock condition and data available for assessments. The southern stock assessment indicates relatively higher stock biomass but is based on a shorter time series of data compared with the northern area. The northern area assessment is based on a much longer time series and stock biomass appears to be at a lower level compared to B_0. Changes in minimum size limits may have compromised the ability to estimate recent recruitments and trip limits may have also compromised fishery CPUE data used as indices of abundance.

Pacific whiting is overfished. A strong year-class will help rebuilding.

B.1.1.2 Pacific Whiting (*Merluccius productus*), also called Pacific hake, is a codlike species distributed off the west coast of North America from 25° N. to 51° N. lat. The coastal stock of Pacific whiting is currently the most abundant groundfish population in the California current system. The fishery for Pacific whiting has supported total annual catches that have averaged in excess of 200,000 mt annually. The 2001 stock assessment indicated a recent series of poor recruitments and a spawning biomass of 20% of the unfished stock. Because mature female spawning biomass was estimated to be less than 25% of an unfished stock abundance, NOAA Fisheries Service designated the Pacific whiting stock to be overfished in 2002. (Helser 2002a). A more recent stock assessment indicated the stock biomass was larger than previously estimated, and NOAA Fisheries has declared the stock no longer overfished.





Historically, Pacific whiting spawn in January through April off southern California, and then migrate northward towards Vancouver Island, Canada. In recent years, spawning has been detected in northern areas, including Canadian waters.

Distribution and Life History Pacific whiting are a semi-pelagic roundfish distributed from the Gulf of California to the Gulf of Alaska and east to Asia in depths from 0 to 500 fm (usually in depths <125 fm). They are similar to true cods, but are in the family Merlucciidae due to some differences in internal and external structures. There are genetic differences between the West Coast whiting population and those found in the larger, semi-enclosed inlets of Puget Sound and the Strait of Georgia as well as the southern stock off Baja California. Only the main coastal population off the Pacific Coast waters of

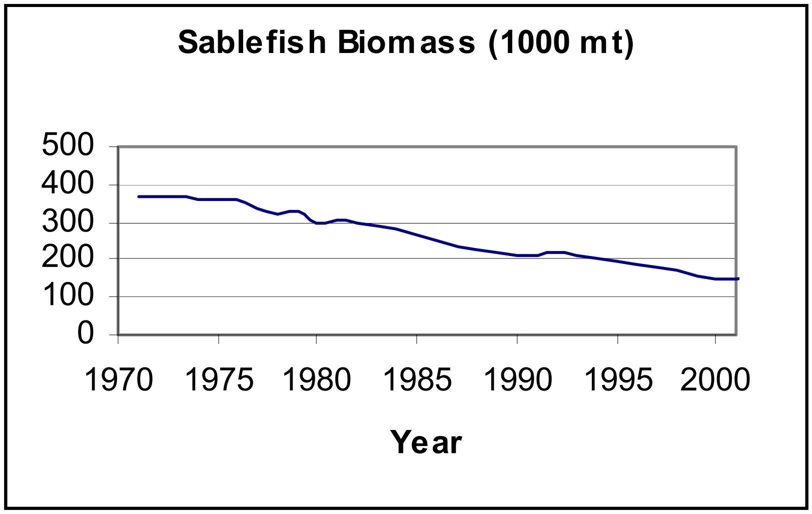
WOC are within Council purview and addressed here. The coastal Pacific whiting stock ranges from southern California to Queen Charlotte Sound. Spawning occurs off southern California during January to March and then the stock migrates northward to feed in the waters off the continental slope and shelf from northern California to Vancouver Island (PFMC 2002b).

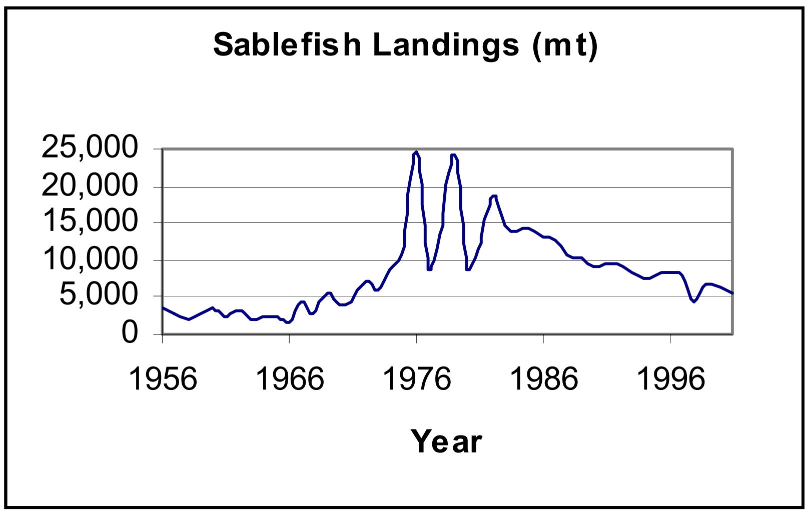
Pacific whiting is a trans-boundary stock - a joint U.S. and Canada assessment was conducted in 2001.

Stock Status and Trends The Pacific whiting fishery is annually assessed and managed jointly with the Canadian Department of Fisheries and Oceans. A total U.S./Canada ABC is determined from the assessment and the U.S. portion has been 80% of the ABC. A 1998 assessment concluded the stock was at moderate abundance (Dorn *et al.* 1999). Stock biomass increased to a historical high of 5.7 million mt in 1987 due to exceptionally large 1980 and 1984 year classes, then declined as these year classes passed through the population and were replaced by more moderate year classes. Stock size has been relatively stable over the past four years at 1.7 to 1.8 million mt. The mature female biomass in 1998 was estimated to be 37% of an unfished stock. Although 1998 stock size was near a historical low, it was close to average stock size under current harvest policies. The exploitation rate was below 10% prior to 1993, then increased to 17% during 1994 through 1998.
An update of the 1999 assessment was prepared in 2001 (Helser *et al.* 2002b). The fishery age composition and recruitment indices showed no indication of strong recruiting year classes, suggesting a continuing pattern of weak to moderate year classes consistent with the 1998 assessment. Yield projections from the 2000 assessment update for 2001 were within 5% of the projected yield for the 1998 model. The 1998 model projections were used to obtain the 2001 ABC. Whiting catch in 2000 will be approximately 75% of the ABC due to the scarcity of fishable aggregations of whiting off northern Washington and southeast Vancouver Island during the summer season. A “40-10” adjustment is made to the ABC to calculate the OY (with an $F_{40\%}$ MSY proxy harvest rate) since this stock is in the “precautionary zone”. The 1999 and 2000 OYs were based on an average value for the two years as the stock declined in abundance. The 2001 OY (190,400 mt) and 2002 OY (129,600) reflect reductions due to the current lower abundance. ABC for 2003 is 188,000 mt and the Council recommended OY for 2003 is 148,200 mt (PFMC 2002c).

B.1.1.3 Sablefish (*Anoplopoma fimbria*) are found from the southern tip of Baja California to the Gulf of Alaska, westward to the Aleutian Islands, and in gullies and

deep canyons at depths greater than 109 fm (200m). The stock is currently between 27% and 38% of unfished biomass. "Precautionary" management principles are being applied and the ABC for sablefish is reduced by the 40-10 rule.





Distribution and Life History. While sablefish in the Northeastern Pacific Ocean are known to be highly migratory (Heifetz and Fujioka 1991; Maloney and Heifetz 1997), it appears there may exist at least three different stocks of sablefish along the west coast of North America. One stock south of Monterey Bay is characterized by slow growth and a small maximum size (Cailliet *et al.* 1988; Phillips and Imamura 1954). Another stock distributed from northern California to Washington is characterized by moderately fast growth and a large maximum size (Fujiwara and Hankin 1988; Methot 1994; 1995). This second stock supports the bulk of the fisheries in the Washington, Oregon, and California (WOC) management area and was the subject of the most recent stock assessments. A third sablefish stock distributed from British Columbia, Canada and in the Gulf of Alaska has the fastest growth rate and attains the largest size in the Northeastern Pacific (Mason *et al.* 1983; McFarlane and Beamish 1990; Methot 1995). The sablefish stock assessment assumes a single unit stock for sablefish within Vancouver through Conception management areas (Schirripa and Methot 2001).

Age at 50% maturity is about 6 years for sablefish. Sablefish grow rapidly to maturity and both sexes stop growing at about 10 years of age, and have been known to reach ages of 55 years or more (Love 1991). Sablefish can reach sizes in excess of 1 meter in length. In the most recent assessment, the largest female aged was estimated to be between 80 and 82 years of age and was 102 cm in length. Mature females of the same age are generally larger than males. Sablefish spawn in deep water between October and April (Love 1991). Young-of-the-year swim onto the shelf and live at or near the surface. Some portion of adult sablefish appear to make seasonal migrations from deeper water off the continental slope and canyon areas onto the continental shelf during the summer months. Adult sablefish are top carnivores that feed primarily on fishes, cephalopods, and crustaceans (Low *et al.* 1976; Shaw 1984).

Sablefish recruitment appears to be correlated with periods of high copepod production associated with favorable climate and ocean conditions (King *et al.* 2000). A 15-year zooplankton time series off southern Vancouver Island showed large interannual anomalies of zooplankton biomass (Mackas *et al.* 2001; Schirripa and Methot 2001). Mackas *et al.*(2001) reported a significant relation between estimates of sablefish recruitment and these copepod anomalies.

The sablefish OY is allocated among users.

Stock Status and Trends. Sablefish harvest is allocated among the major commercial fishery sectors. (Recreational fishers rarely target sablefish and are not included within the allocation framework.) Overall fishing mortality is divided among tribal longline and domestic trawl, pot, longline, and hook and line fisheries. Currently, the tribal sablefish longline fisheries are allocated 10% of the total catch OY. The remaining 90% of the total catch OY was discounted 24 mt in 2002 for research then divided between open access (9.4% of the non-tribal OY) and limited entry fisheries (90.6% of the non-tribal OY). The limited entry allocation is divided between the trawl sector (58%) and the fixed gear sector (42%). Estimated discard mortality ranges from 3% to 22% and is deducted from total catch OY for each fishery sector.

A major uncertainty is the recruitment levels prior to 1980 when stock biomass was higher.

In 2001, two assessments were prepared for the sablefish stock north of Monterey (Hilborn *et al.* 2001; Schirripa and Methot 2001). Both assessments indicated a normal decline in biomass since the late 1970s due to the fishing down of the virgin stock and an unexpected decline in recruitment during the early 1990s. No reliable estimates of recruitment area available prior to 1980 when stock biomass was higher, adding uncertainty to the present assessment. See STAR Panel Report in PFMC(2002a). Sablefish stock status was updated in 2002. Newly available 2001 data documented two relatively strong incoming cohorts, the 1999 and 2000 year classes (Schirripa 2002).

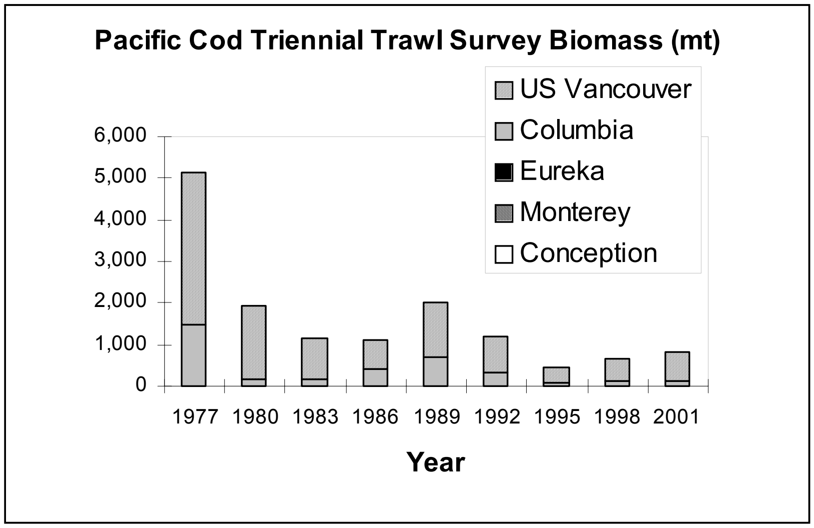
Declines in sablefish abundance are likely due to normal fishing down process and recent poor recruitment tied to environmental conditions.

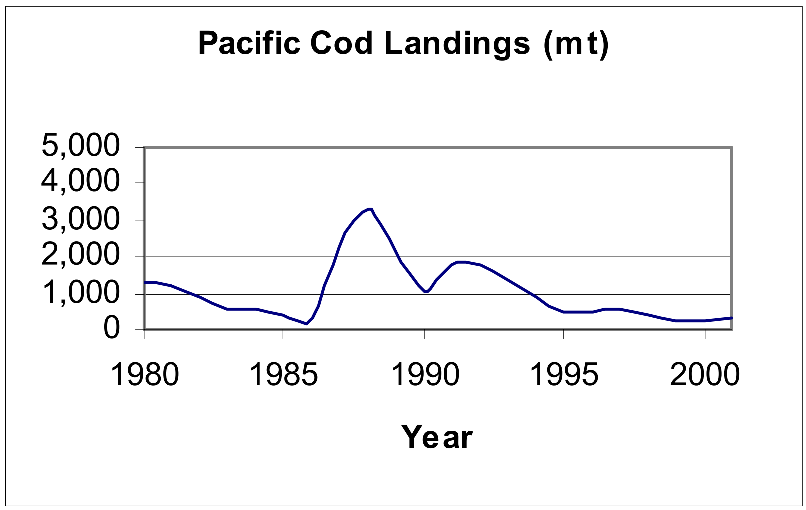
Change in environmental conditions may have been responsible for the abrupt decline in recruitment in the 1990s, or this low recruitment may have been the natural consequence of the gradual decline in spawning biomass. The sablefish stock is currently estimated to be between 27% and 38% of the unfished biomass depending on the assessment scenario and the basis for estimating unfished biomass. The harvest policy for sablefish sets target fishing mortality rate at F_{45}, the instantaneous rate of fishing mortality that, in theory, should maintain a minimum spawning biomass at 45% of virgin spawning biomass. Consequently, estimated sablefish abundance falls within the "precautionary zone" and is subject to the Council's 40-10 harvest policy (Schirripa and Methot 2001).

Abundance of Pacific Cod in PFMC waters is largely controlled by environmental conditions and productivity off Canada and Alaska.

B.1.1.4 Pacific Cod (*Gadus macrocephalus*)

are an important component of Canadian and Gulf of Alaska trawl fisheries. Periodic strong recruitment events increase trawl catches significantly of the Washington and Oregon coasts. Stock status in the West Coast management area is unknown.





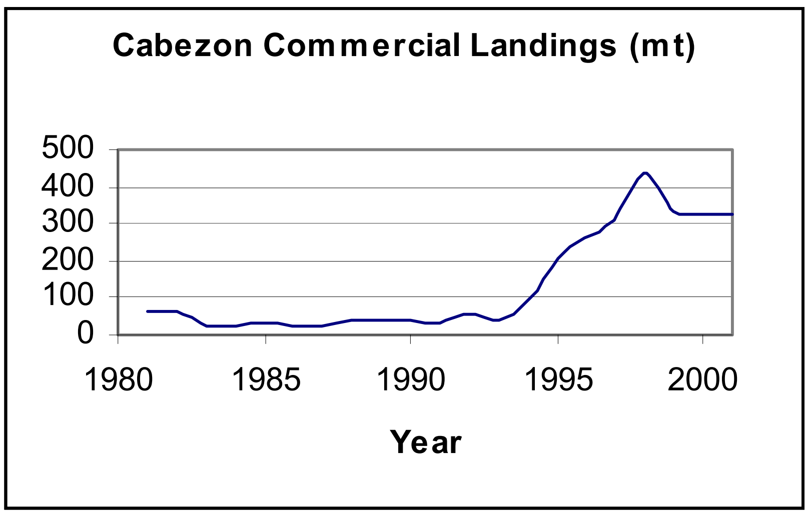
Distribution and Life History Pacific cod are widely distributed in the coastal north Pacific, from the Bering Sea to southern California in the east, and to the Sea of Japan in the west. Adult Pacific cod occur as deep as 481 fm (875 m) (Allen and Smith 1988), but the vast majority occur between 28 fm (50 m) and 165 fm (300 m) (Allen and Smith 1988; Hart 1973; Love 1991; NOAA 1990). Along the West Coast, Pacific cod prefer shallow, soft-bottom habitats in marine and estuarine environments (Garrison and Miller 1982), although adults have been found associated with coarse sand and gravel substrates (Garrison and Miller 1982; Palsson 1990).

Pacific cod have a fairly high rate of natural mortality and rapid growth rate (Hart 1973). Females reach 40 cm at 2 to 3 years - the age of first maturity. At 60 cm, females may produce 1.2 million eggs. Fifty percent of the males are mature at age 2. Larvae and small juveniles are pelagic; large juveniles and adults are parademersal (Dunn and Matarese 1987; NOAA 1990). Adult Pacific cod are not considered to be a migratory species. There is, however, a seasonal bathymetric movement from deep spawning areas of the outer shelf and upper slope in fall and winter to shallow middle-upper shelf feeding grounds in the spring (Dunn and Matarese 1987; Hart 1973; NOAA 1990; Shimada and Kimura 1994).

Stock Status and Trends The GMT set coastwide ABC for Pacific cod at 3,200 mt in 1989 near the highest catch on record. The coastwide catch reported by PacFIN shows a steady decline each year since then to about 1,500 mt in recent years. No quantitative assessment has been attempted for Pacific cod off Washington, Oregon, and California, because changes in stock abundance in this area are probably dominated by environmental factors which influence the contribution of fish from the north (PFMC 1999b).

B.1.1.5 Cabezon (*Scorpaenichthys marmoratus*)

is the largest member of the sculpin family (Cottidae) and an important component of the nearshore recreational and commercial fisheries in the Washington, Oregon, and California management area (Weeks 2002).



Distribution and Life History Cabezon are found from central Baja California north to southeast Alaska (Eschmeyer *et al.* 1983; Hart 1973). The species is found in inshore waters from the intertidal out to depths of about 42 fm (76 m). It is most common at depths of 2.5 fm to 30 fm (5-59 m). Cabezon are found on rocky, sandy and muddy bottoms, and in kelp beds (Love 1996). They inhabit restricted home ranges based on a California tagging study (Leet *et al.* 1992). Fish tagged and displaced demonstrated some ability to return to their home area.

Cabezon have been reported to reach sizes of 39 in. (99cm) and 30.8 lb (14 kg). Expected maximum size from age and growth observations in California and Puget Sound are closer to 25 in (64.5 cm). Cabezon may live up to 20 years. A 25 inch (65 cm) male from Puget Sound was estimated to be 17 years old, and a 28 inch (72.5 cm) female was estimated to be 16 years old. Limited information suggests that males start to mature at age 3 and all are mature at age 4. Females begin to mature at age 4 and all may be mature at age 6.

Spawning takes place from late October to March in California (peaking in January), and from November through September (peaking in March and April) in Washington. Fecundity ranges from 49,000 eggs (produced by a 43 cm female) to 152,000 eggs (produced by a 77 cm female). Eggs are deposited in clusters in shallow waters or in the low intertidal on bedrock, or in crevices. Males guard the nest after spawning and nest sites may be re-used from year to year (Lauth 1987; Lauth 1988). Eggs hatch two to three weeks after spawning. Small juveniles spend three to four months in the water column feeding on small crustaceans and other zooplankton. At about 1.5 inches (approximately 4 cm) they take up a demersal life-style.

Cabezon prey largely on crustaceans, with differences based on size. Adults prey on crustaceans (crabs, small lobster), mollusks(squid, octopus, abalone), smaller fishes, and fish eggs. Small juveniles prey on copepods, amphipods, and larval barnacles. Small cabezon are preyed on by larger fishes including rockfishes, lingcod, adult cabezon, and other sculpins. Adults are taken by pinnipeds.

Eggs are reported to be poisonous to humans. They are lethal to laboratory test animals, and are avoided by potential natural predators such as raccoons, mink, and birds (Hubbs and Wick 1951; Parsons 1986; Pillsbury 1957).

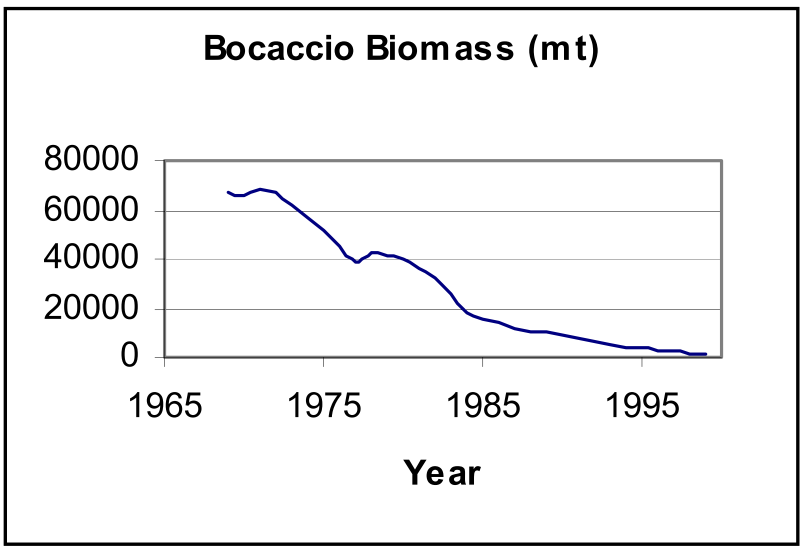
Status of Stocks and Trends There have been no quantitative assessments of cabezon populations. California Department of Fish and Game and the Oregon Department of Fish and Wildlife have ongoing nearshore reef mapping projects that may become the basis for stock assessments on cabezon and other nearshore reef species (Fox 2003). Until 2002, no species specific allowable biological catch (ABC) or optimum yield (OY) has been set for cabezon as they were included in a larger grouped OY for “other groundfish”. Most of the catch is taken by commercial fishers. Coastwide commercial catches increased rapidly in the 1990s and peaked in 1998 at 434 mt, principally

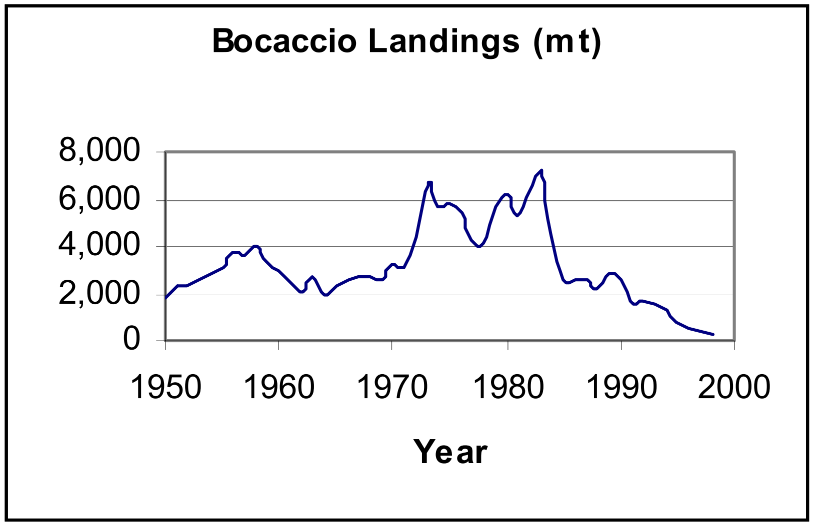
due to the increase effort in the live-fish fishery (PacFIN 2002a).
Oregon and California currently have 14 inch minimum size limits. The Council is considering minimum size limits of 15 to 16 inches for 2003.

B.1.2 Rockfish

The southern California bocaccio stock has been designated as overfished, with current biomass substantially below the 25% threshold.

B.1.2.1 Bocaccio (*Sebastes paucispinis*) is a rockfish species that ranges from Kodiak Island, Alaska south to central Baja California. The most recent published assessment for bocaccio (MacCall *et al.* 1999) indicated the stock off California was considerably below the overfished level. An unpublished update (MacCall 2002) concluded that stock remained in the severely overfished state and projections indicated rebuilding will take decades. Current regulations are intended to reduce harvest of this stock to near zero.





Distribution and Life History Love *et al*. (2002) and Thomas and MacCall (2001) described bocaccio distribution and life history. Bocaccio are historically most abundant in waters off central and southern California. Juveniles settle in nearshore waters after a several month pelagic stage. Adults range from depths of 6.5-261 fm (12-478 m). Most adults are caught off the middle and lower shelf at depths between 27 fm and 137 fm (50 and 250 m). Larger fish tend to be deeper. Bocaccio are found in a wide variety of habitats: often on or near bottom features but sometimes over muddy bottoms. While usually found near the bottom they also occur as much as 16.4 fm (30 m) off bottom. Tagging studies have shown that young fish move up to 148 km (92 miles).

Most adults occur on the middle and lower shelf.

Maximum age of bocaccio was radiometrically determined to be at least 40 and perhaps more than 50 years. Bocaccio are difficult to age and the assessment was length based. MacCall *et al*.(1999) estimated that the instantaneous rate of natural mortality was 0.20 (82% adult annual survival when there is no fishing mortality). Fifty percent of 48 cm (19 in) females are mature. Maximum size is 91 cm (36 in) and 6.8 kg (15 lb). Bocaccio are live bearers. Parturition occurs from October through July peaking January- February off California. Fecundity ranges from 20,000 to 2,300,000 eggs. Females produce up to three batches of larvae per year off southern California.

Adult bocaccio feed on fish and squid.

Little is known about ecological relationships between bocaccio and other organisms. Adult bocaccio are often caught with chilipepper rockfish and have been observed schooling with speckled, vermilion, widow, and yellowtail rockfish. Bocaccio begin feeding on other fish such as smaller rockfish and squid in their first year. Young bocaccio are known to be consumed by sea birds, chinook salmon, and harbor seals..

Status of Stocks and Trends Bocaccio have long been an important component of California fisheries for rockfish. Catches increased to high levels in the 1970s and early 1980s as relatively strong year-classes recruited to the stock. The Council began to recommend increasingly restrictive regulations after an assessment in 1990 (Bence and Hightower 1990) indicated that fishing rates were too high. The most recent assessment (MacCall *et al.* 1999) indicated that the stock is severely overfished and that estimates of stock productivity had been over-optimistic. An unpublished update (MacCall 2002) concluded that stock remained in the severely overfished state and projections indicated that rebuilding will take decades. The Council is developing recommendations to limit catches to near zero.

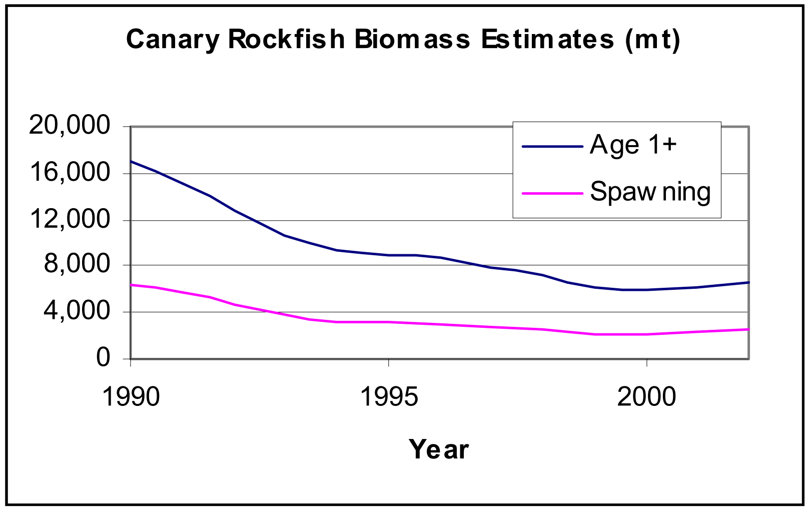
Natural mortality is moderate for bocaccio and maximum age is at least 40 years.

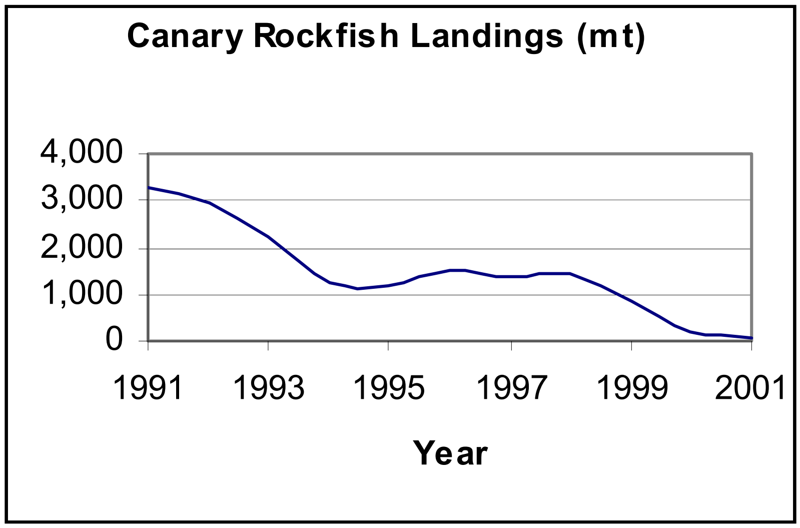
There is little doubt the bocaccio stock off California is severely overfished, but there are considerable uncertainties in the assessment. Genetic studies indicate that bocaccio off California are distinct from bocaccio off the Pacific northwest, but no work has been done to compare stocks off Baja California with stocks off California. Bocaccio off Mexico and the northwest have not been assessed. The rate of natural mortality was not well determined. Species composition data were lacking for pre-1980 catches and had to be estimated with data from later years. There appeared to be considerable error in the age composition data and they were not useful for the assessment.

There are considerable uncertainties in the bocaccio assessment, but there is little doubt the stock is overfished.

B.1.2.2 Canary Rockfish (*S. pinniger*) range from the western Gulf of Alaska to northern Baja California and are most abundant from British Columbia to central California. The last published assessments for canary rockfish (NMFS 1999b; Williams *et al.* 1999) indicated that stock was below and perhaps considerably below the overfished level. An unpublished update (Methot and Piner 2002) concluded that stock was in a severely overfished state and projections indicated that rebuilding will take decades. Current management measures severely limit catches.

Canary rockfish biomass is considerably below the overfished level.





Distribution and Life History Love *et al*. (2002) and Williams and Adams (2001) described canary rockfish distribution and life history. Juveniles settle in nearshore waters after a several month pelagic stage. Adults range from depths of 25-475 fm (46-868 m). Most adults are caught off the middle and lower shelf at depths between 44 fm and 109 fm (80 and 200 m). Larger fish tend to be deeper. Canary rockfish are usually associated with areas of high relief such as pinnacles, but also occur over flat rock or mud and boulder bottoms. They are usually found near the bottom. A tagging study showed that they can move up to 700 km (435 miles).

Most adults occur on the middle and lower shelf.

Maximum age of canary rockfish is 84 years. The three assessments (1999) estimated that the instantaneous rate of natural mortality was 0.06 (94% adult annual survival when there is no fishing mortality). Mature females may have higher natural mortality rates. Fifty percent of 38 cm (13.4 in and 7 years) females are mature. Maximum size is 76 cm (30 in) and

Natural mortality is low and maximum age is at least 84 years.

7.8 kg (17 lb). Females tend to be larger than males of the same age. Female canary rockfish reach 90% of their expected maximum size at 15 years. Canary rockfish are live bearers. Parturition occurs from September through March peaking December- January. Fecundity ranges from 260,000 to 1,900,000 eggs.

Adults feed on euphausiids, gelatinous zooplankton, and small fish.

Little is known about ecological relationships between Canary rockfish and other organisms. Adult canary rockfish are often caught with bocaccio, sharpchin, yelloweye, and yellowtail rockfishes, and lingcod. Researchers also have observed canary rockfish associated with silvergray, and widow rockfish. Young of the year feed on copepods, amphipods, and young stages of euphausids. Adults feed on euphausiids, gelatinous zooplankton, and small fish. Small canary rockfish are consumed by sea birds, chinook salmon, and marine mammals.

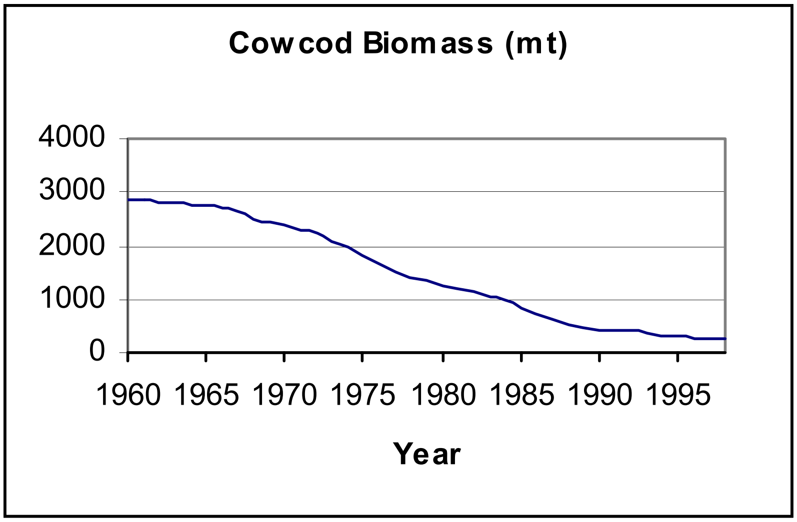
Stock Status and Trends Canary rockfish have long been an important component of fisheries for rockfish. The Council began to recommend increasingly restrictive regulations after an assessment in 1994 (Sampson and Stewart 1994) indicated that fishing rates were too high. The most recent assessments {Williams, 1999 #1499; NMFS, 1999b #1435} indicated that the stock was below and perhaps considerably below the overfished level. An unpublished update (Methot and Piner 2002) concluded that stock was in a considerably overfished state and projections indicated that rebuilding will take decades. The Council is developing recommendations to severely limit catches.

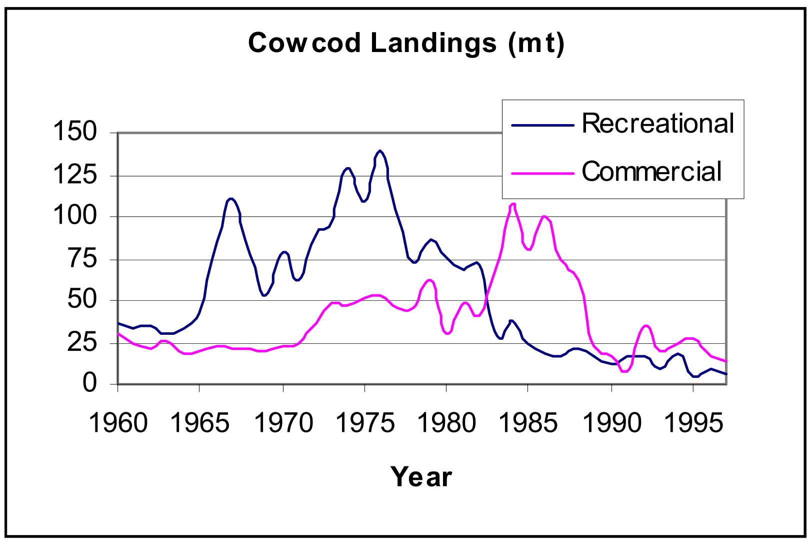
There are considerable uncertainties in the canary rockfish assessment but little doubt the stock is overfished.

There is little doubt the West Coast canary rockfish stock is overfished, but there are considerable uncertainties in the assessment. Genetic studies indicate that canary rockfish off California and southern Oregon may be different than fish to the north. However, the assessment by Williams *et al*. (1999) produced evidence suggesting that at least some recruitment to the southern area may come from fish to the north. No research has been done on the relationship between canary rockfish off Washington and British Columbia, but the assessment assumes that there is no relationship. The rate of natural mortality, especially for mature females, was not well determined. Species composition data was lacking for pre-1980 catches and had to be estimated with data from later years. The frequency of adult surveys and aerial coverage of recruitment surveys was inadequate.

The cowcod stock has been designated as overfished.

B.1.2.3 Cowcod (*S. levis*) is a species of large rockfish that ranges from Newport, Oregon to Isla Guadalupe, central Baja California. The only assessment for cowcod (Butler *et al.* 1999) indicated that stock off Southern California is below the overfished level. Current regulations are intended to reduce catches to as low as possible.





Distribution and Life History Love *et al*. (2002) and Barnes (2001) described cowcod distribution and life history. They are most abundant in waters off central and southern California. Young of the year have been observed on fine sand and clay sediment as well as oil platform shell mounds and other complex bottom features at depths ranging from 22-122 fm (40-224 m). Adults range from depths of 39-268 fm (72-491 m). Most adults occur on the lower shelf and upper slope at depths deeper than 82 fm (150 m) and 164 fm (300 m). Adults are often found on bottoms with high relief such as rocky reefs.

Maximum age of cowcod rockfish is 55 years and maximum size is 94 cm (37 in) and 13 kg (28.5 lb). The instantaneous rate of natural mortality is estimated at about 0.08 (92% adult annual survival when there is no fishing mortality) (Butler *et al.* 1999). Fifty percent of 43 cm (17 in) (about 11years old) females are mature. Average size at age of mature females is similar to males. Females reach 90% of their maximum expected size by 40 years (Butler *et al.* 1999). Cowcod are livebearers. Most larvae are released January through February. Fecundity is dependent on size and ranges from 181,000 to 1,925,000 eggs. Southern females may release more than one batch per year.

Little is known about ecological relationships between cowcod and other organisms. Small cowcod feed on planktonic organisms such as copepods. Larger animals such as fish, squid, and octopus have been found in stomachs of adult fish.

Most adults occur on the bottom in deep waters of the outer shelf and upper slope.

Stock Status and Trends While cowcod are not a major component of the groundfish fishery, they are highly desired by both recreational and commercial fishers because of their bright color and large size. The most recent assessment (Butler *et al.* 1999) indicated that the stock is considerably below the overfished level. The Council has recommended regulations to reduce catches to as low as possible. Large areas off southern California have been closed to fishing for groundfish.

Natural mortality is low and maximum age is 55 years.

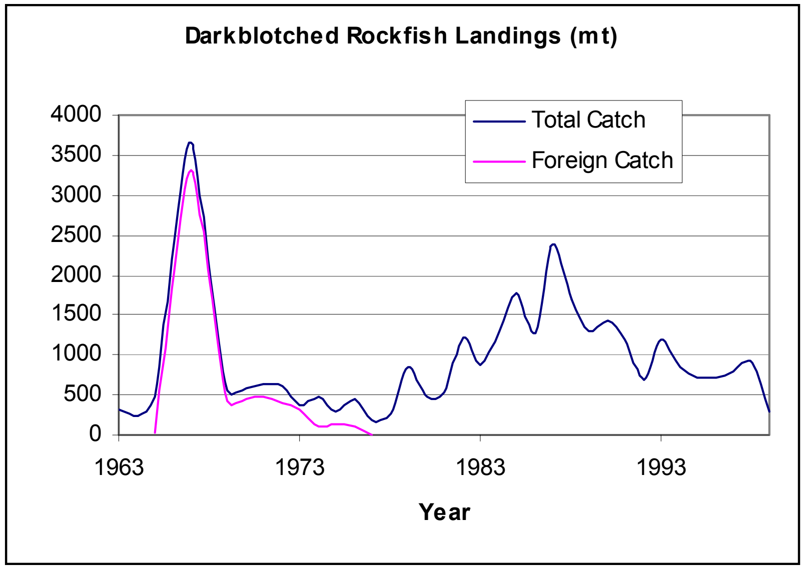
There is relatively little information about the cowcod stock and there are major uncertainties in the assessment. The assessment authors needed to make estimates of early landings based on more recent data and reported total landings of rockfish. Age and size composition of catches are poorly sampled. Population structure is unknown and the assessment was restricted to southern California waters. Since the species is not very abundant, it has been difficult to develop fishery independent indices of trends in abundance.

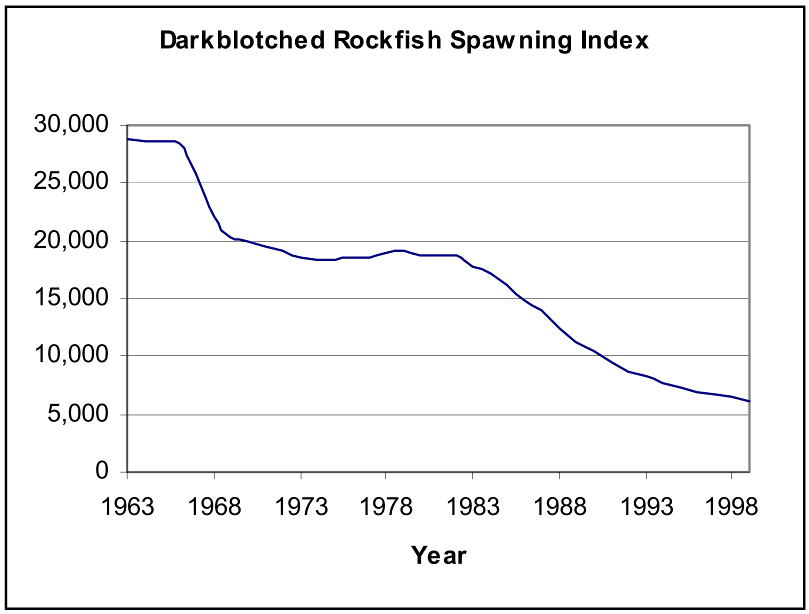
Darkblotched rockfish are overfished.

B.1.2.4 Darkblotched Rockfish (*S. crameri*)

occur from Tanaga Island (Aleutian Islands) and Bering Sea to near Catalina Island, California. They are most abundant from Oregon to British Columbia.

The latest assessment Rogers *et al*. (2000) indicated that darkblotched rockfish were overfished. The Council determined a darkblotched rockfish OY for the first time and recommended regulations to restrict catches.





Distribution and Life History Love *et al*. (2002) described darkblotched rockfish distribution and life history. Young of the year recruit to bottom at depths ranging from 30-109 fm (55-200 m) after spending up to 5 months as pelagic larvae and juveniles in offshore waters. Adults range from depths of 14-494 fm (25-904 m). Most adults occur on the lower shelf and upper slope at depths between 77 fm and 200 fm (140 m and 365 m). Adults are often found on mud near cobble or boulders. Fish tend to move into deeper waters as they age.

Most adults occur on the bottom of the lower shelf and upper slope.

Maximum age of darkblotched rockfish is 64 years. Rogers *et al*. (2000) estimated that the instantaneous rate of natural mortality was about 0.05 (95% adult annual survival when there is no fishing mortality). Fifty percent of 34.5 cm (13.6 in) (about 10 years old) females are mature (Nichol 1990). Average size at age of mature females is greater than males. Females reach 90% of their maximum expected size by 13 years (Rogers *et al.* 2000). Maximum size is 58 cm (23 in) and 2.3 kg (5.1 lb). Darkblotched rockfish are livebearers. Most larvae are released December through February. Fecundity is dependent on size and ranges from 20,000 to 610,000 eggs.

Adults feed on midwater organisms such as euphausiids and

Little is known about ecological relationships between darkblotched rockfish and other organisms. Pelagic juveniles feed on planktonic organisms such as copepods. Adults are often caught with other fish such as Pacific Ocean perch and splitnose rockfish. Midwater animals such as euphausiids and amphipods dominate the diet of adult fish. Albacore and chinook salmon consume pelagic juveniles. Little is known about predation of adults.

Stock Status and Trends Darkblotched rockfish are not a major component of the groundfish fishery. Foreign trawlers fishing for Pacific Ocean Perch made relatively large catches during the 1960s. A small group of fishers found a concentration of darkblotched rockfish off northern California and made relatively large catches in 1987. There is little fisheries dependent data available. The first assessment (Lenarz 1993) did not attempt to estimate biomass, but warned that life history characteristics indicated that productivity was low and decreases in fish size suggested that the stock had been impacted by the fishery. Rogers *et al*. (2000) estimated biomass and found that the stock was overfished. Beginning in 2001, the Council recommended an OY and management measures to begin rebuilding the stock.

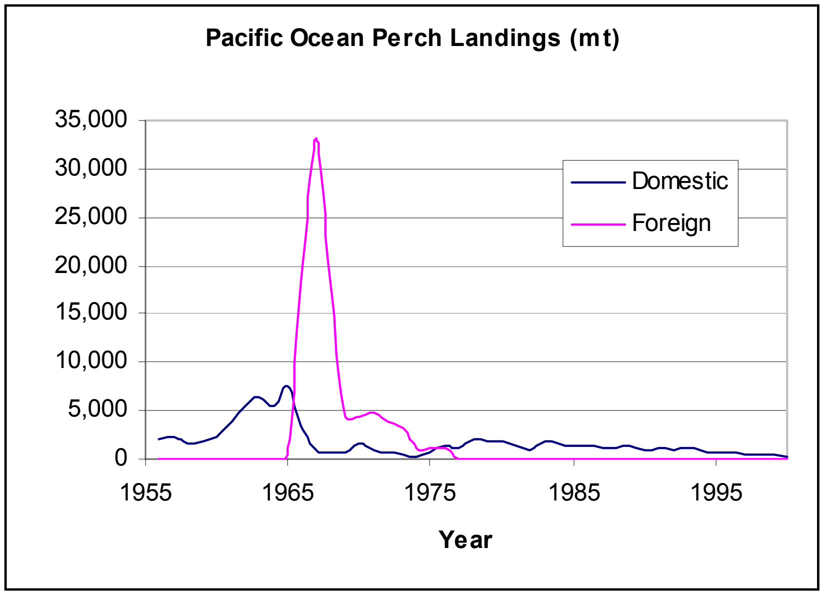
There are considerable uncertainties in the assessments.

There are major uncertainties in the assessments. The assessment model estimate of unfished biomass is very sensitive to catches made by the foreign fishery in the 1960s. The foreign catches are poorly known, but new information is being evaluated. The domestic fishery is poorly sampled for age and size composition of darkblotched rockfish. The level of discards is poorly known. Trawl surveys were designed for other species and were not optimal for darkblotched rockfish. Stock structure is not known.

POP has been designated as overfished; recovery is expected by 2011.

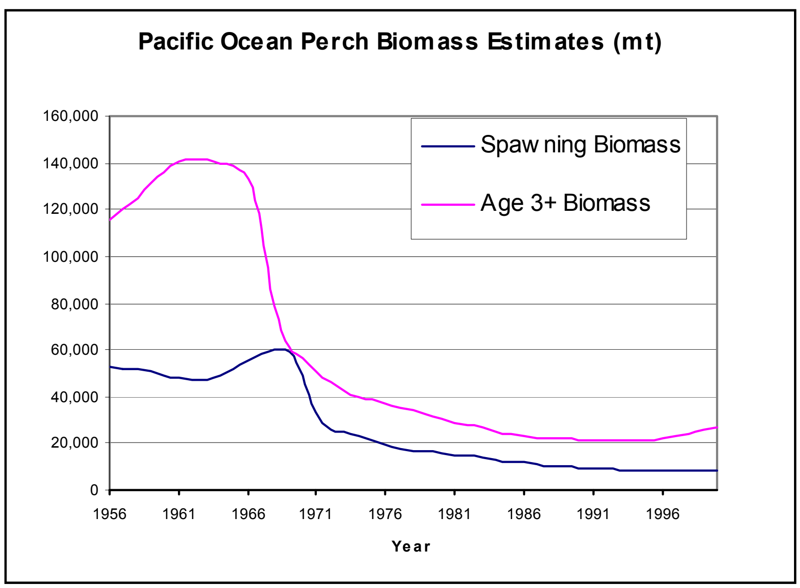
B.1.2.5 Pacific Ocean Perch (*S. alutus*) was over harvested by foreign fishing vessels prior to 1976. Since 1981, the Council has considered the Pacific Ocean Perch (POP) stock to be overfished, and has recommended conservative harvest policies to hasten rebuilding. The most recent assessment

(Ianelli *et al.* 2000) indicated that, after a long period of little change, the stock increased slightly in recent years. Projections indicated that the stock will likely recover to near or above the maximum sustainable yield level by 2011.



Most adults live in upper slope waters of the north Pacific.

Distribution and Life History Love *et al*. (2002) described POP distribution and life history. POP occur in western north



Pacific south to Honshu Japan, southern Bering Sea, and eastern north Pacific south to Baja California. They are common from northern California to the Kuril Islands and are the most abundant rockfish in the Gulf of Alaska. The shallowest recorded depth for juveniles is 37 m (122 ft/20.3 fathoms). Adults range from 49.5 fm (90 m) to at least 454 fm (830 m).

Most adults occur in upper slope waters at 109-150 fm (200-275 m) during the summer and occur at 164-246 fm (300-450 m) during the winter. Adults at times aggregate 0-16 fm (0-30 m) above hard-bottom features and may then disperse and rise into the water column at night (Love *et al.* 2002). However, Krieger (1993) indicated that POP generally live as adults near or on the bottom, generally in areas with smooth bottoms.

Natural mortality is low and maximum age is at least 100 years.

Maximum age of POP is at least 100 years (Love *et al.* 2002). Ianelli *et al*. (2000) estimated that the instantaneous rate of natural mortality was about 0.056 (95% adult annual survival when there is no fishing mortality). Age of maturity varies with locality. Ianelli *et al* (2000) assumed that 50% of 10 year old POP were mature, and also examined the assumption that 50% were mature at 8 years. Size at age also varies with locality (Love *et al.* 2002). POP reach 90% of their maximum size by age 20 years. Average size at age of mature females is greater than males. Maximum size is 53 cm (21 in) and 2.05 kg (4.5 lb). POP are livebearers. Most larvae are released February through May. Fecundity is dependent on size and ranges from 10,000 to 505,000 eggs. Researchers have not captured sufficient numbers of early stages to obtain an understanding of the early life history.

Adult POP eat krill and are eaten by marine mammals and larger fish.

Little is known about ecological relationships between POP and other organisms. Adult POP are often caught with other upper slope groundfish such as Dover sole, thornyheads, sablefish, and dark blotched, rougheye, and sharpchin rockfish. Small POP feed primarily on zooplankton such as copepods (Love *et al.* 2002; NMFS 2001b). Euphausiids dominate the diet of larger POP. Fur seals, sablefish, and Pacific halibut prey on sub-adult and adult POP. Albacore and salmon consume pelagic juveniles. Lingcod and other groundfish prey on benthic juveniles.

Stock size appears to be increasing.

Stock Status and Trends. Very high catches during the 1960s caused a rapid decrease in stock biomass. Domestic fishers were the sole exploiters of POP until 1965. Large trawlers from Japan and Russia entered the fishery. Catches increased from 8035 mt (375 mt foreign) in 1965 to 34,089 mt (33,204 mt foreign) in 1967. The stock could not sustain the high catches and total catch by the unregulated fishery decreased to 19,375 mt in 1968 and was only 2,512 mt in 1976. The Council determined that the stock was depleted in 1981 and recommended conservative harvest policies before the FMP was implemented in 1982. The Council formulated policies aimed at allowing continued fishing on other species while minimizing directed fishing on POP. The Council recommended more restrictive policies as experience showed that the stock was not rebuilding. The most recent assessment (Ianelli *et al.* 2000) indicated that the stock had started to increase, but still may be below the overfished level. The Council continues to allow only very low exploitation and the stock is projected to recover to near or above the MSY level by 2011.

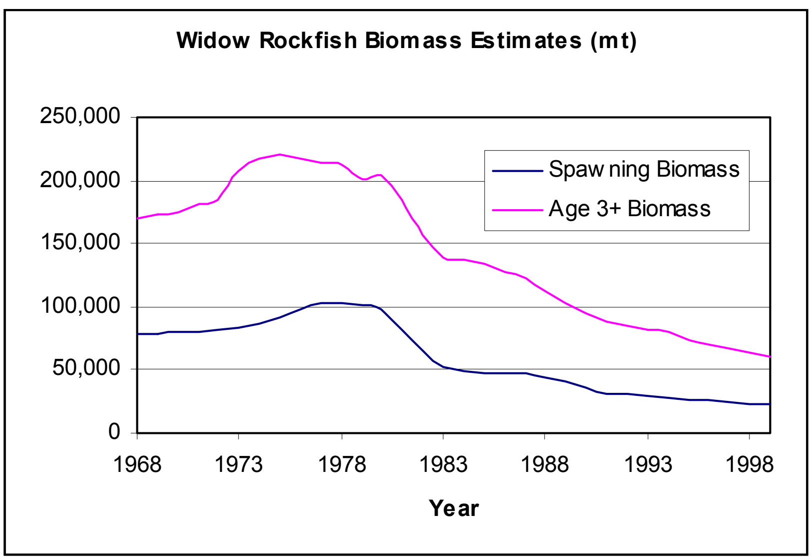
There are considerable uncertainties about the stock status.

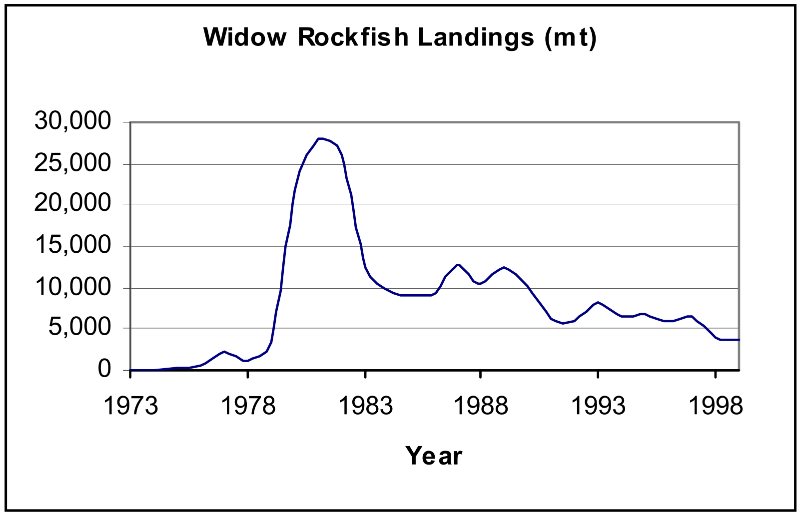
Several factors cause considerable uncertainties in the assessment. Species composition of catches by the USSR in the early fishery is not well known. There may be significant unreported discards by the domestic fleet in recent years. Resources are not sufficient to determine age composition of recent commercial and research catches. The assessment was not able to provide a definitive relationship between spawning biomass and recruitment. POP within the Council's jurisdiction may not be a distinct stock.

The widow rockfish stock has been designated overfished.

B.1.2.6 Widow Rockfish (*S. entomelas)* occur from near Kodiak Island, Alaska to Bahia de Todos Santos, Baja California. They are most abundant off northern Oregon and southern Washington and are one of the most abundant West Coast rockfish.

In 1982 the Council concluded that unrestricted fishing would deplete the widow rockfish stock and recommended restrictive harvest policies. Recruitment did not reach expectations and there was a long term decline in the stock. The most recent assessment (Williams *et al.* 2000) indicated that the stock had fallen below the overfished level. The Council recommended a very restrictive harvest policy to rebuild the stock.





Most adults are found near the shelf break and sometimes form large mid-water schools.

Distribution and Life History Love *et al*. (2002) and Ralston and Lenarz (2001) described widow rockfish distribution and life history. Young of the year recruit to shallow nearshore waters after spending up to 5 months as pelagic larvae and juveniles in offshore waters. Adults range from bottom depths of 13 fm to 300 fm (24 m to 549 m). Most adults occur near the shelf break at bottom depths between 77 fm to 115 fm (140 m to 210 m). Adults are semi-pelagic and their behavior is dynamic. They sometimes form large mid-water schools. At other times they may be dispersed either in mid-water or on the bottom. The large aggregations usually occur above bottom features known to fishermen.

Natural mortality is fairly low and maximum age is 59 years.

Maximum age of widow rockfish is 59 years (Ralston and Lenarz. 2001). Williams et al. (2000) estimated that the instantaneous rate of natural mortality was about 0.15 (86% adult annual survival when there is no fishing mortality). Age of maturity varies with locality. Barss and Echeverria (1987) found that 50% of 5 year old female widow rockfish were mature off California, and 50% of 7 year old fish were mature off Oregon. Size at age also varies with locality (Pearson and Hightower 1991). Female widow rockfish reach 90% of their maximum size by age 14 years off Oregon and by age 12 years off California. Average size at age of mature females is greater than males. Maximum size is 59 cm (23 in) and 3.3 kg (7.3 lb). Widow rockfish are livebearers. Most larvae are released January through March. Fecundity is dependent on size and ranges from 56,000 to 1,100,000 eggs.

Adults feed on midwater organisms such as small fish and euphausiids.

Little is known about ecological relationships between widow rockfish and other organisms. Adults are often caught with yellowtail rockfish off Washington, but California and Oregon fishers often make large pure catches of widow rockfish from mid-water schools. Small widow rockfish feed primarily on zooplankton such as copepods. Midwater animals such as euphausiids, small fish, sergestids, and salps dominate the diet of larger fish. Sea birds and chinook salmon consume pelagic juveniles. Little is known about predation of adults.

Stock Status and Trends The total catch of widow rockfish since 1960 is greater than any other species of rockfish in the Council jurisdiction. Catches were modest until mid-water trawlers began exploiting large schools in 1979. Landings by the unregulated fishery rapidly increased to 28,146 mt in 1981. Biologists documented that the stock was being impacted. Regulations were implemented in late 1982, but landings were still high, 25,967 mt. The Council recommended much more restrictive regulations in 1983 and landings were reduced to 12,594 mt. Regulations changed as knowledge of the productivity of the stock improved, but recruitment averaged less than expected. The most recent assessment (Williams *et al.* 2000) estimated that the stock was slightly below the overfished level as defined by FMP Amendment 11. The Council recommended very low harvest levels as required by the Amendment for overfished stocks. The harvest levels did not match those used in the assessment for projections, but interpolation indicated that expected biomass levels would be close to recovered levels by 2009.

The widow rockfish stock is currently expected to rebuild by 2009.

Several factors caused uncertainties in the assessment. The lack reliable surveys to estimate biomass of adults causes considerable uncertainty in projections and estimates of recent biomass levels. Discards have seldom been estimated or sampled. Stock assessment authors have considerable difficulty in estimating long term stock productivity because the relationship between spawning stock and recruitment is not well understood. The relationship and exchange rates of fish between the northern and southern stock areas is not known. Exchange rates of fish between U.S. and Canadian waters is not known, but assumed to be zero.

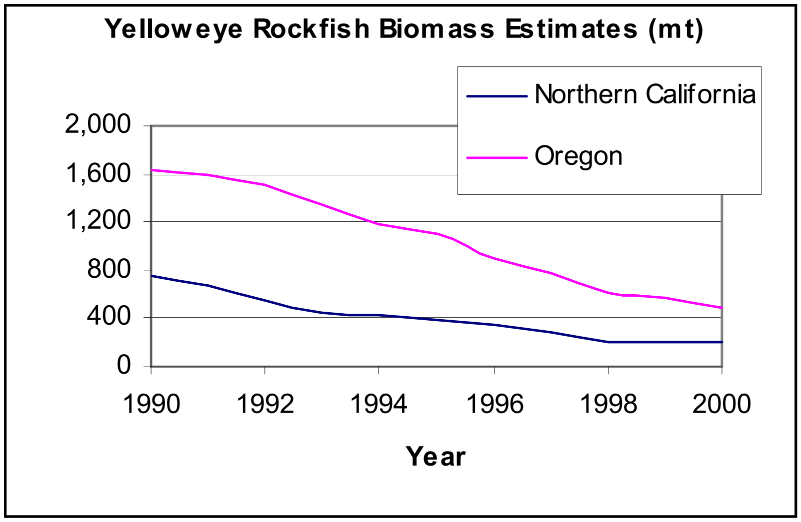
There are considerable uncertainties in the assessments.

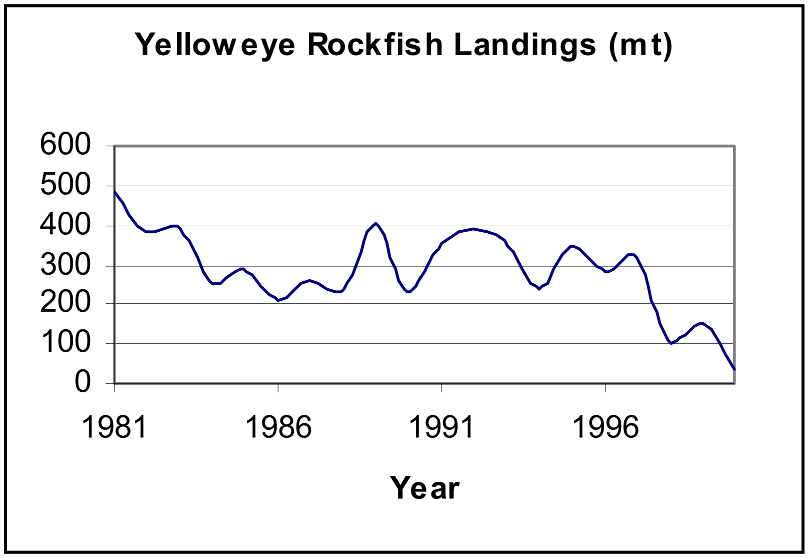
B.1.2.7 Yelloweye Rockfish (*S. ruberrimus*)

range from Umnak Island, Aleutian Islands to Ensenada, northern Baja California. They are most abundant from southeastern Alaska to central California.

The yelloweye rockfish stock is overfished.

The only assessment for yelloweye rockfish (Wallace 2001) indicated that stocks off northern California and Oregon were considerably below the overfished level. Current regulations severely limit catches.





Distribution and Life History Love *et al*. (2002) described yelloweye rockfish distribution and life history. Juveniles have been found at depths greater than 8 fm (15 m) in areas of high bottom relief. Adults range to depths of 300 fm (549 m). Most adults are caught off the middle and lower shelf at depths between 50 fm and 98 fm (91 m and 180 m). Adult yelloweye rockfish tend to be solitary and are usually associated with areas of high relief with refuges such as caves and crevices, but also occur on mud adjacent to rock structures. They are usually found on or near the bottom.

Most adults occur on the middle and lower shelf.

Maximum age of yelloweye rockfish is 115 years. There are no published estimates of the instantaneous rate of natural mortality. Fifty percent of 46 cm (18 in and 19 years) females are mature. Maximum size is 91 cm (36 in) and 11.3 kg (25 lb). Females tend to be slightly larger than males of the same age. Yelloweye rockfish are live bearers. Parturition occurs from

March through September and peak May- June. Fecundity ranges from 1,200,000 to 2,700,000 eggs.

Maximum age for yelloweye rockfish is at least 118 years.

Little is known about ecological relationships between yelloweye rockfish and other organisms. Researchers have observed adult yelloweye rockfish associated with bocaccio, cowcod, greenspotted, and tiger rockfish. Adults feed on rockfishes, herring, sandlance, flatfishes, lingcod eggs, shrimp, and crab. Chinook salmon prey on small yelloweye and an orca stomach contained a yelloweye rockfish.

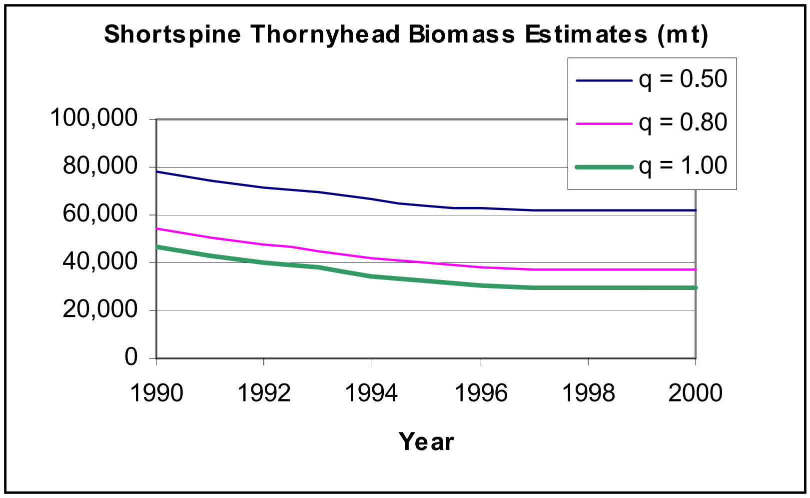
Stock Status and Trends Yelloweye rockfish have been a minor component of fisheries for rockfish. Catches have decreased in recent years. The only assessment for yelloweye rockfish (Wallace 2001) indicated that stocks off northern California and Oregon were considerably below the overfished level. Current regulations severely limit catches.

There is relatively little information about yelloweye rockfish and there are major uncertainties in the assessment. The assessment did not have sufficient fishery dependent data from the important Washington fishery or reliable fishery independent survey data to use. Life history data are questionable, and population structure is not known.

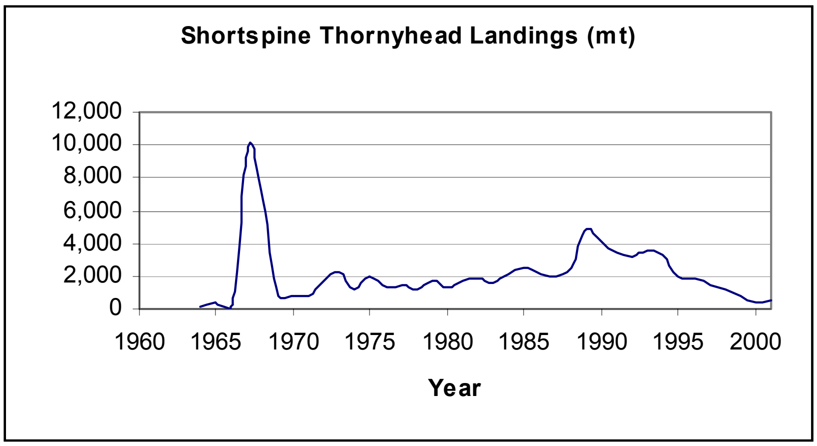
Shortspine thornyhead biomass is above the overfished level and below the target levels.

B.1.2.8 Shortspine Thornyhead (*Sebastolobus alascanus)* occur in the Sea of Japan, Sea of Okhotsk, Bering Sea, and eastern Pacific Ocean south to central Baja California. They are most abundant in waters off central California to the northern Kuril Islands.

The most recent assessment for shortspine thornyhead (Piner and Methot 2001) indicated that stock remains above the overfished level, consistent with the previous assessment by Rogers *et al*. (1998). An independent assessment, summarized but not published by the NOAA Fisheries Service Stock Assessment Team and Ocean Trust Stock Assessment Team (1998) indicated that the stock was closer to target levels. The most recent assessment indicates the stock to be between 24% and 48% of unfished biomass.



Most adults occur on the bottom of the upper slope to middle slope.



Distribution and Life History Love *et al*. (2002) and Barnes *et al*. (2001) described shortspine thornyhead distribution and life history. Juveniles settle to the bottom at depths of 55 fm to 328 fm (100 m to 600 m) after a 14-15 month pelagic stage. Immature and adult fish are often on mud bottoms usually near cobblestones, sponges and other small bottom features. Adults are also found on rocky bottoms. Adults range to depths of 833 fm (1,524 m) and often inhabit the oxygen-minimum layer off of California (Jacobson and Vetter 1996). Most adults occur on the upper to middle slope at depths between 82 fm (150 m) and 547 fm.

Natural mortality of shortspine thornyhead is low and maximum age is at least 80 years.

Maximum age of shortspine thornyhead is at least 80 and probably more than 100 years. Rogers *et al*. (1998) assumed an instantaneous rate of natural mortality of 0.06 based on a maximum age of 80 years (94% adult annual survival when there is no fishing mortality). Fifty percent of 22 cm (8.7 in) (about 12 years old) females are mature. Females reach 90% of their maximum expected size by about 80 years (Kline 1996). Maximum size is 80 cm (31.5 in) and 8.0 kg (17.6 lb). Shortspine thornyheads spawn gelatinous egg masses.

Spawning occurs from January through May with a peak in April off California. Fecundity ranges up to 400,000 eggs.

Adults feed on benthic invertebrates and fish such as smaller thornyheads.

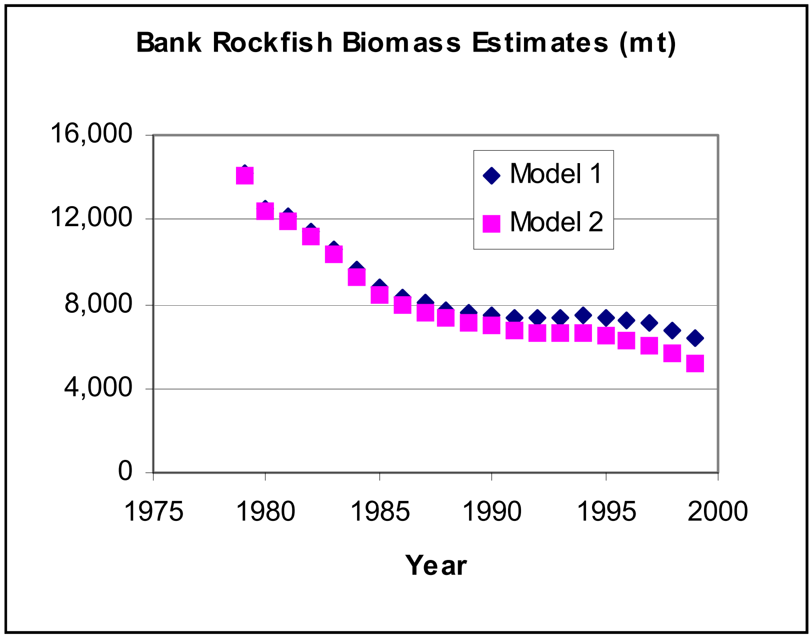
Little is known about ecological relationships between shortspine thornyheads and other organisms. Adult shortspine thornyheads are often caught with Dover sole, sablefish, and longspine thornyheads. Adults feed on fish such as smaller shortspine and longspine thornyheads, and benthic shrimp, amphipods, and crabs. California sea lions prey on shortspine thornyheads.

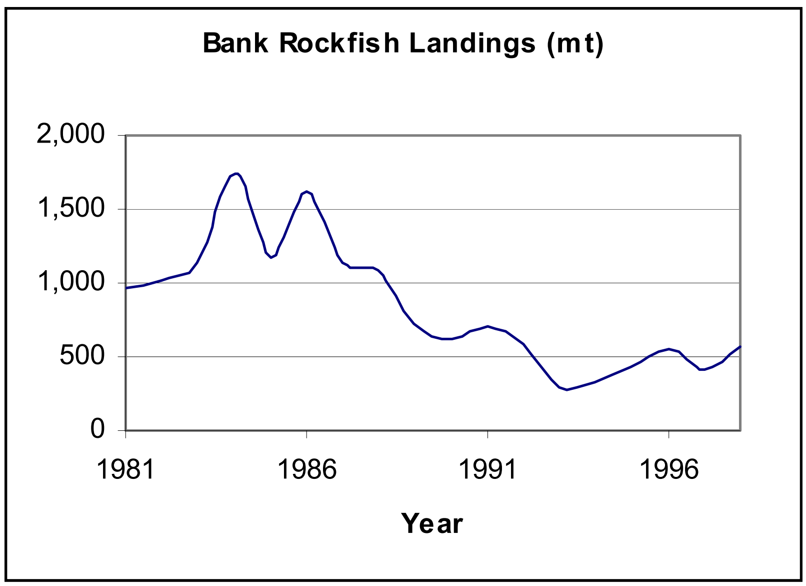
Stock Status and Trends Shortspine thornyheads are an important economic component of the groundfish fishery. Catches increased as markets developed and both demand and prices increased. Regulations became progressively more restrictive after 1989, with separate catch limits for shortspine thornyhead instituted in 1995. The most recent assessment (Piner and Methot 2001) indicates that spawning biomass is between 24% and 48% of unfished biomass levels.

Assessment of the shortspine thornyhead stock presents many challenges, as the information about stock abundance and trends is somewhat limited. This results in major uncertainties in the assessment. Model results indicate an upward trend in biomass, assuming recruitment remains constant. Sparse data and unknown life history traits contribute to the uncertainty in the true population dynamic. NMFS surveys have not covered the full range of the species off California, Oregon and Washington, and there are serious questions about estimates of "**q**" (the catchability coefficient) for the survey that was used. Stock structure is not known and the assessment only included data from central California to the Canadian border.

The bank rockfish stock is estimated to be slightly above the overfished level.

B.1.2.9 Bank Rockfish (*Sebastes rufus*) occur from Queen Charlotte Sound, British Columbia Sea to Isla Guadalupe, central Baja California. The latest assessment (Piner *et al.* 2000) indicated that bank rockfish were slightly above the overfished level. The Council recommends regulations for the slope rockfish group as a whole.





Natural mortality is low and maximum age is 85 years.

Most adults occur on the bottom of the lower shelf and upper slope.

Distribution and Life History Love *et al*. (2002) and Love and Watters (2001) described bank rockfish distribution and life history. They are most abundant from central California to at least southern California. Young of the year have been observed in boulder fields at depths ranging from 52-115 fm (95-210 m). Adults range from depths of 71-248 fm (130-454 m). Most adults occur on the lower shelf and upper slope at depths between 71 fm (130 m) and 197 fm (360 m). Adults are often found on or above bottoms with high relief. Fishers are reported to have made large catches from aggregations over bottom features.

Maximum age of bank rockfish is 85 years. Piner *et al*. (2000) used its longevity to estimate that the instantaneous rate of natural mortality was about 0.08 (92% adult annual survival when there is no fishing mortality). Fifty percent of 30 cm (12 in) (about 8 years old) females are mature. Average size at age of mature females is greater than males. Females reach 90% of their maximum expected size by 22 years (Piner *et al.* 2000). Maximum size is 55 cm (22 in) and 2.4 kg (5.2 lb). Bank rockfish are livebearers. Most larvae are released January through February. Fecundity is dependent on size and ranges from 65,000 to 608,000 eggs. Southern females may spawn more than once per year.

Adults feed on midwater organisms such as krill and amphipods.

Little is known about ecological relationships between bank rockfish and other organisms. Adults are often caught with other fish such as blackgill, darkblotched and splitnose rockfish. Midwater animals such as euphausiids and gelatinous plankton have been found in stomachs of adult fish.

Stock Status and Trends Bank rockfish are not a major component of the groundfish fishery and are the species is poorly known. Regulations aimed at reducing catches of other rockfish species probably contributed to the decline in catches of bank rockfish. The most recent assessment (Piner *et al.* 2000) indicated that the stock is slightly above the overfished levels. The Council neither sets OY for bank rockfish nor recommends regulations directed at bank rockfish. The GMT believes that regulations for slope rockfish as an aggregate are sufficient to restrict the fishery for bank rockfish to levels that will maintain the stock.

There is relatively little information about bank rockfish.

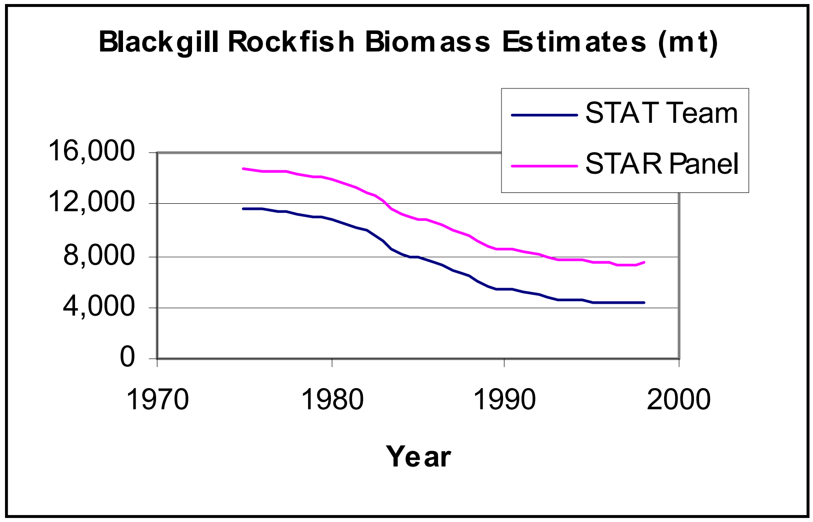
There is relatively little information about bank rockfish and there are major uncertainties in the assessment. The assessment did not have sufficient fishery dependent data from the important southern California fishery or reliable fishery independent survey data to use. Life history data are questionable, and population structure is not known.

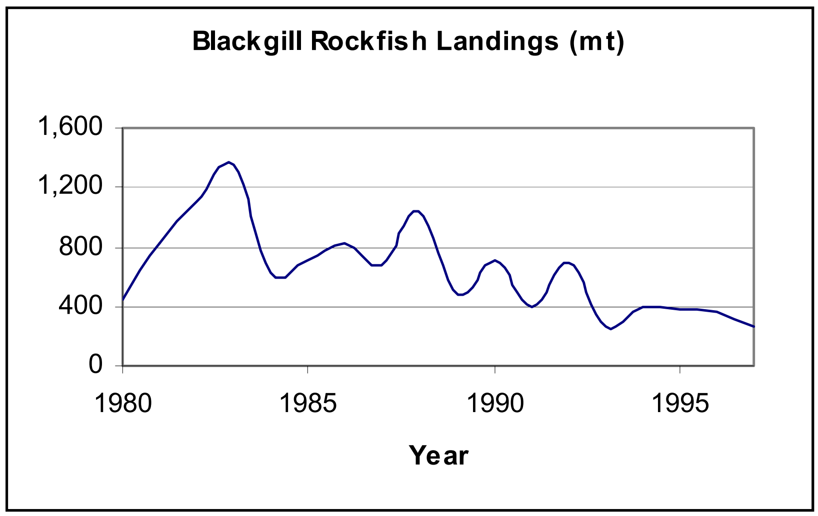
Blackgill rockfish biomass is slightly above the target level.

B.1.2.10 Blackgill Rockfish (*S. melanostomus*)

occur from Vancouver Island, British Columbia to Isla Cedros, central Baja California. They are most abundant in waters off central and southern California.

The only assessment for blackgill rockfish (Butler *et al.* 1998) indicated that stock off California was slightly above the overfished level. The Council recommends regulations for the slope rockfish group as a whole.





Distribution and Life History Love *et al*. (2002) and Love and Butler (2001) described blackgill distribution and life history. Young of the year have generally been caught at depths greater than 109 fm (200 m). Immature fish are usually caught on flat bottoms. Adults range from depths of 48-420 fm (87-768 m). Most adults occur on the upper slope at depths between 137 fm (250 m) and 328 fm (600 m). Adults are often found on bottoms with high relief such as rocky reefs. Fishermen report that they sometimes occur off the bottom.

Maximum age of blackgill rockfish is 87 years. Butler *et al*. (1998) estimated that the instantaneous rate of natural mortality was about 0.047 (95% adult annual survival when there is no fishing mortality). Fifty percent of 34 cm (13 in) (about 20 years old) females are mature. Average size at age of mature females is greater than males. Females reach 90% of their maximum expected size by 56 years (Butler *et al.* 1998). Maximum size is 61 cm (24 in) and 3.3 kg (7.3 lb). Blackgill rockfish are livebearers. Most larvae are released in February off southern California. Fecundity is dependent on size and ranges from 152,000 to 769,000 eggs.

Little is known about ecological relationships between blackgill rockfish and other organisms. Adult blackgill rockfish feed on fish such as lanternfish.

Natural mortality is low and maximum age is 87 years.

Most adults occur on the bottom of the upper slope.

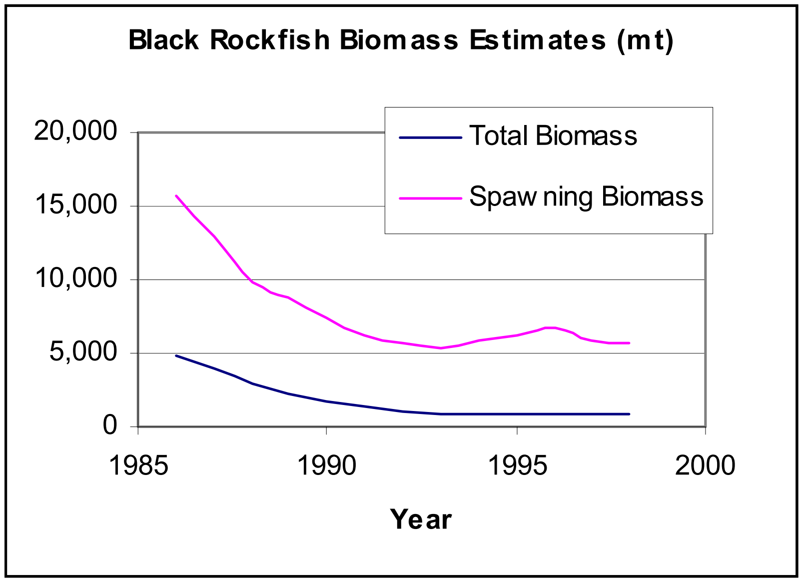
Stock Status and Trends Blackgill rockfish are not a major component of the groundfish fishery. The most recent assessment (Butler *et al.* 1998) indicated that the stock is slightly above target levels. The Council recommends regulations for the slope rockfish group as a whole.

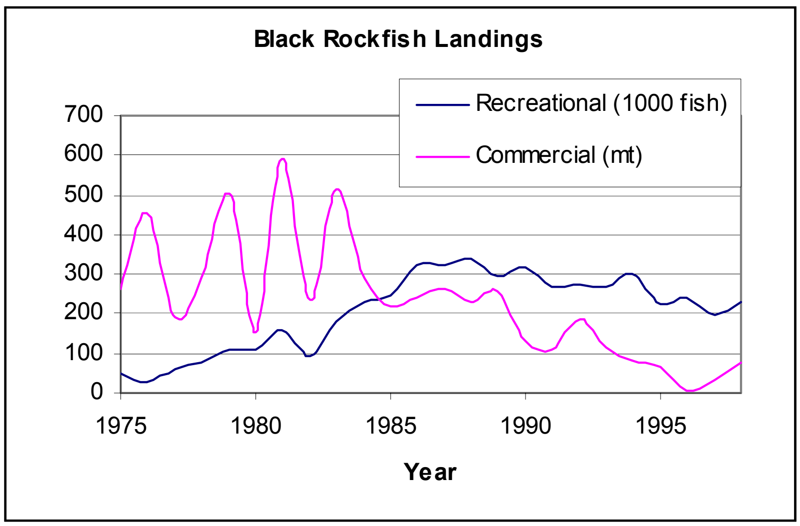
There is relatively little information about blackgill rockfish and there are major uncertainties in the assessment. The stock assessment authors needed to estimate early landings based on more recent data and reported total landings of rockfish. Catches and age and size composition of catches are poorly sampled. The STAT and STAR panel could not agree on estimates of fishing mortality. The assessment stated "Both estimates were educated guesses based on the available data, which were limited." Both estimates indicated that the stock was at or above target levels. Population structure is unknown and the assessment was restricted to U.S. waters. Fish off Mexico may be part of the same stock as U.S. fish.

Black rockfish are above the biomass target level.

B.1.2.11 Black Rockfish (*S. melanops*) occur from Amchitka Island (Aleutian Islands) to Huntington Beach, southern California. They are most abundant from northern California to southeast Alaska and are an important component of recreational fisheries from northern California through Washington.

The most recent assessment (Wallace *et al.* 1999) indicated that there has been a decline in biomass, but the stock off Washington and northern Oregon remains above the target level. Washington regulations are intended to maintain the stock at levels sufficiently high to satisfy the needs of its recreational fishery.





Natural mortality is fairly high (compared to other rockfish species) and maximum age is 50 years.

Distribution and Life History Love *et al*. (2002) and Reilly (2001a) described black rockfish distribution and life history. Young of the year recruit to shallow nearshore waters after spending up to 5 months as pelagic larvae and juveniles in offshore waters. Adults range from the surface to bottom depths of 200 fm (366 m). Most adults occur in nearshore waters at bottom depths less than 30 fm (55 m). Adults are semi-pelagic and their behavior is dynamic. They often form mid-water schools. At other times they may be on the bottom. They are often associated with kelp forests in areas with rocky bottoms.

Most adults are found in nearshore waters and often above the bottom.

Maximum age of black rockfish is 50 years. Wallace *et al*. (1999) estimated that the instantaneous rate of natural mortality for males was about 0..36 (70% adult annual survival when there is no fishing mortality), but that natural mortality of mature females increased with age. Wallace *et al*. (1999) found that 50% of 10.5 year old female black rockfish were mature.

Female black rockfish reach 90% of their maximum size by age 14 years. Average size at age of mature females is greater than males. Maximum size is 69 cm (27 in) and 5 kg (11 lb). Tagging results showed that most adults appear to remain near the area of release, but some moved as far as 619 km (384 miles). Black rockfish are livebearers. Most larvae are released January through March. Fecundity is dependent on size and ranges from 125,000 to 1,200,000 eggs.

Adults feed on midwater organisms such as small fish and krill.

Little is known about ecological relationships between black rockfish and other organisms. Adults are often caught with other fish such as dusky, widow, and yellowtail rockfish. Midwater animals such as small fish and young stages of crabs dominate the diet of adult fish, but they sometimes also consume benthic crustaceans and octopuses. Sea birds and chinook salmon consume pelagic juveniles. Lingcod and sea lions prey on adults.

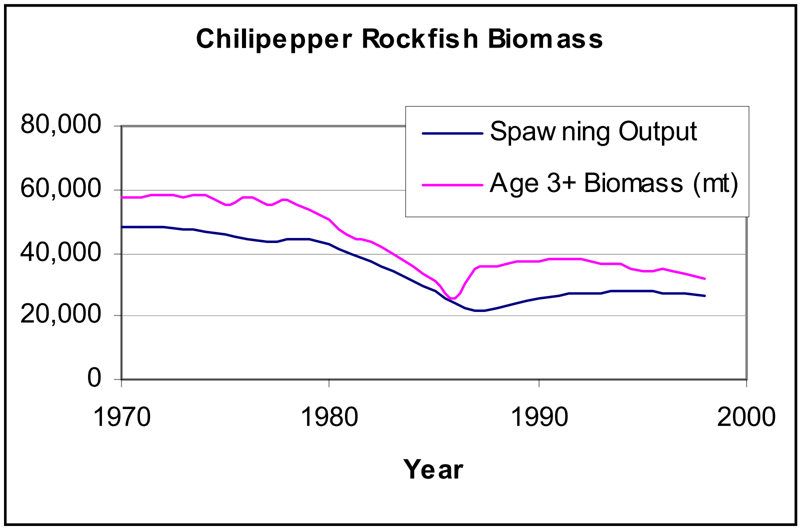
Stock Status and Trends Recreational fishers increased exploitation of black rockfish as salmon population decreased. The state of Washington decided to allocate the nearshore resource of black rockfish to the recreational fishery and implemented regulations to reduce the commercial catch. The Council recommended regulations for northern Oregon and Washington that are consistent with the Washington goals. Wallace *et al*.(1999) presented evidence the black rockfish off northern Oregon and Washington are genetically different from fish to the south and only assessed the northern stock. They estimated that biomass of the northern stock is declining but above target levels. Southern fish have not been assessed. The Council sets ABC for the southern fish at 50% of recent catches per its policy for un-assessed stocks.

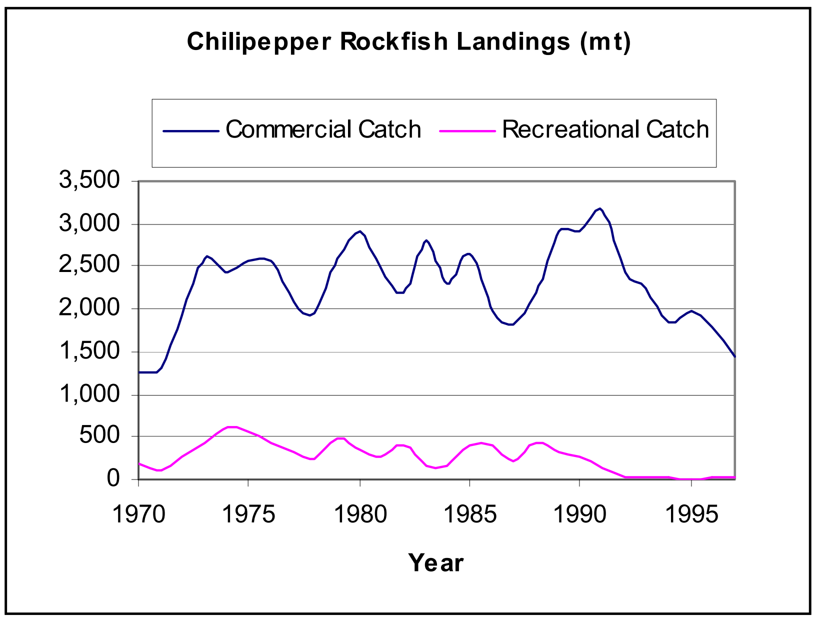
There are considerable uncertainties in the assessments.

There are major uncertainties in the assessments. The only index of biomass was obtained from tagging studies. The assessment model estimates are very sensitive to assumed rate of reporting of tag recoveries. The time series with sufficient data to use for assessment is short. There is genetic evidence that the stock extends into Canada, but the assessment was limited to U.S. waters. Black rockfish are also important for recreational fishing south of northern Oregon, but these stock(s) have not been assessed.

The chilipepper rockfish stock is above the target biomass level.

B.1.2.12 Chilipepper Rockfish (*S. goodei*) are an important component of California groundfish catches. The most recent assessment (Ralston *et al.* 1998) indicated a decline in biomass, but the stock remains above the target level. This species has been managed as a major component of the nearshore rockfish complex.





Distribution and Life History Love *et al*. (2002) and Ralston and Oda (2001) described chilipepper rockfish distribution and life history. Chilipepper rockfish occur from Queen Charlotte Sound, British Columbia to Magdalena Bay, Baja California. They are most abundant from Cape Mendocino to Point Conception and are one of the most abundant rockfish of the central California. Young of the year recruit to shallow nearshore waters usually just outside of kelp beds after spending up to 5 months as pelagic larvae and juveniles in offshore waters. Adults range from bottom depths of 25-268 fm (46-491 m). Most adults occur over the lower shelf and upper slope at bottom depths between 41 fm (75 m) and 168 fm (325 m). Adults are semi-pelagic and are found on deep rocky reefs as well as sand and mud bottoms. At times, they form large schools.

Maximum age of chilipepper rockfish is 35 years. Ralston *et al*. (1998) estimated that the instantaneous rate of natural mortality was about 0.22 for females and 0.25 for males (78-80% adult annual survival when there is no fishing mortality). Fifty percent of 3 year old females are mature. Female chilipepper rockfish reach 90% of their maximum size by age 13 years. Average size at age of mature females is greater than males. Maximum size is 59 cm (23 in) and 3.2 kg (7 lb). Chilipepper rockfish are livebearers, and most larvae are released December through January. Fecundity is dependent on size and ranges from 18,000 to 538,000 eggs.

Natural mortality is fairly high for rockfish and maximum age is 35 years.

Little is known about ecological relationships between chilipepper rockfish and other organisms. Pelagic juveniles feed on planktonic organisms such as copepods. Adults are often caught with bocaccio. Midwater animals such as euphausiids and small fish dominate the diet of adult fish. Sea birds and chinook salmon consume pelagic juveniles. Little is known about predation of adults.

Adults feed on midwater organisms such as small fish and euphausiids.

Stock Status and Trends Chilipepper rockfish are an important component of catches by California fishers. The most recent assessment estimated that the biomass of chilipepper rockfish is above target levels. The council recommends regulations for the nearshore complex of rockfish, including chilipepper, as a group. These regulations probably have reduced catches of chilipepper rockfish in recent years because of restrictions aimed at protecting the overfished stock of bocaccio.

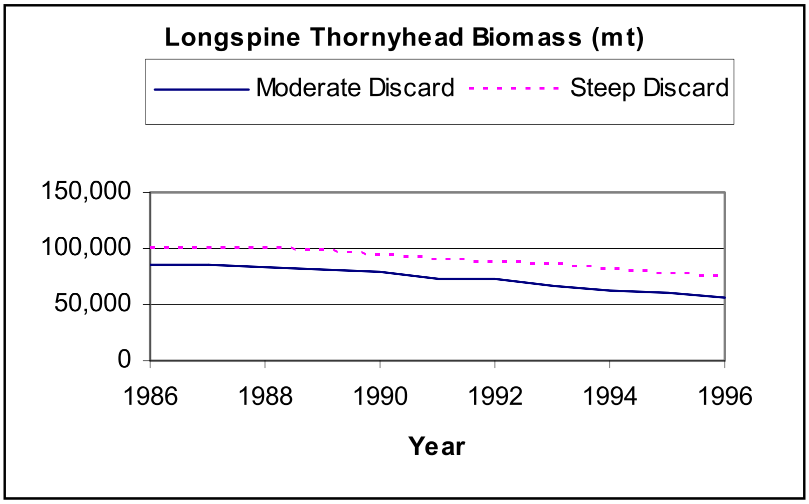
There are major uncertainties in the assessment. Catches of chilipepper rockfish prior to 1980 were estimated from compositions of rockfish catches after 1980. Catches by the fishery independent trawl survey for biomass were not aged. Logbooks did not report rockfish catches by species, and the assessment authors needed to estimate the species composition. The assessment did not include data from Mexico. The relationships between stock(s) of chilipepper in Mexican waters and the US stock is not known. The two survey estimates of adult abundance were somewhat disparate. Factors controlling recruitment strength were poorly known and there was difficulty in projecting future recruitment.

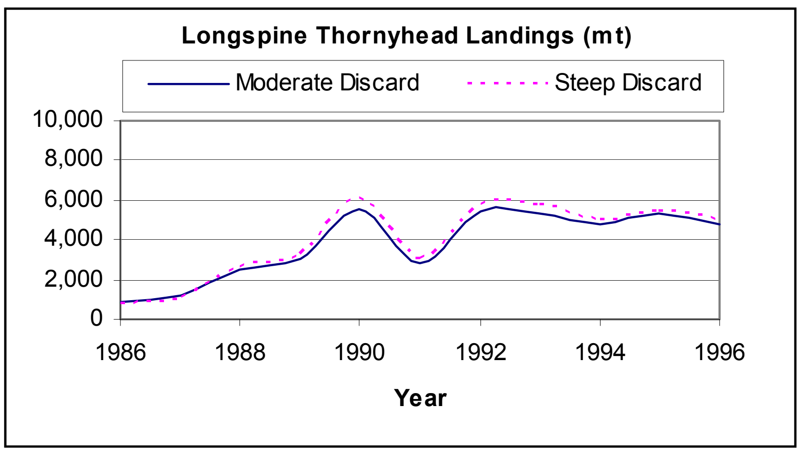
There are considerable uncertainties in the assessment.

Longspine thornyheads are thought to be above 40% of the unfished biomass level.

B.1.2.13 Longspine Thornyhead

(*Sebastolobus altivelis*) are an important trawl-caught species thought at or above target levels. They are managed within the Dover sole, thornyhead, and sablefish complex. Longspine thornyheads have an overlapping distribution with shortspine thornyeads. The most recent assessment completed in 1997 (Rogers *et al.* 1997) indicated longspine thornyhead to be above 40% of the unfished biomass level.





Distribution and Life History Longspine thornyhead are found from the southern tip of Baja California to the Aleutian Islands (Eschmeyer *et al.* 1983; Hart 1973; Jacobson and Vetter 1996; Love 1991; Miller and Lea 1972; Smith and Brown 1983) but are abundant from southern California northward (Love 1991). Juvenile and adult longspine thornyhead are demersal and occupies the benthic surface (Smith and Brown 1983). Off Oregon and California, longspine thornyhead mainly occur at depths of 219-766 fm (400-1,400 m), most between 328 fm (600 m) and 547 fm (1,000 m) in the oxygen minimum zone (Jacobson and Vetter 1996). Thornyhead larvae (*Sebastolobus* spp.) Have been taken in research surveys up to 560 km off the

California coast (Cross 1987; Moser *et al.* 1993). Juveniles settle on the continental slope at about 328-656 fm (600-1,200 m) . Longspine thornyhead live on soft bottoms, preferably sand or mud (Eschmeyer *et al.* 1983; Jacobson and Vetter 1996; Love 1991). Longspine thornyheads neither school nor aggregate (Jacobson and Vetter 1996).

Longspine thornyhead distribution overlaps shortspine thornyhead but typically do not extend as deep. They don't live as long as shortspine thornyheads and mature at a smaller size.

Spawning occurs in February and March at 328-547 fm (600-1,000 m) (Jacobson and Vetter 1996; Wakefield and Smith 1990). Longspine thornyhead are oviparous (egg layers) and may spawn 2-4 times per year (Love 1991; Wakefield and Smith 1990). Eggs rise to the surface to develop and hatch. Floating egg masses can be seen at the surface in March, April, and May
(Wakefield and Smith 1990). Juveniles (<5.1 cm long) occur in midwater (Eschmeyer *et al.* 1983). After settling, longspine thornyhead are completely benthic (Jacobson and Vetter 1996). Longspine thornyhead can grow to 38 cm (Eschmeyer *et al.* 1983; Jacobson and Vetter 1996; Miller and Lea 1972) and live more than 40 years (Jacobson and Vetter 1996). Longspine thornyhead reach the onset of sexual maturity at 17-19 cm (10% of females mature) and 90% are mature by 25-27 cm (Jacobson and Vetter 1996).

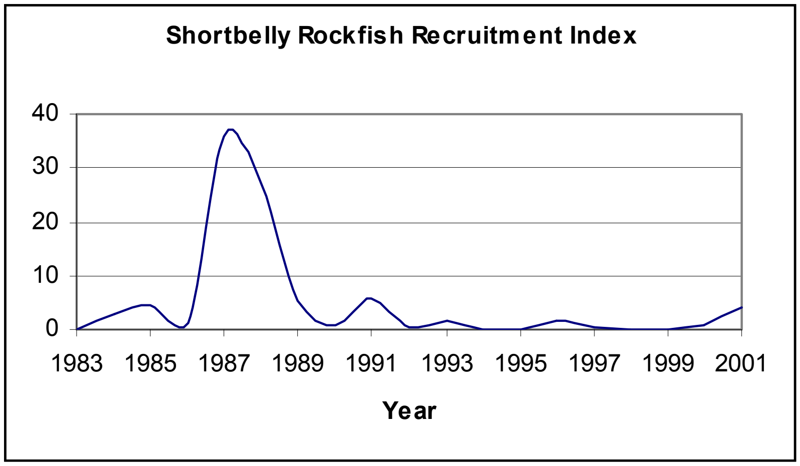
Longspine thornyhead are ambush predators (Jacobson and Vetter 1996). They consume fish fragments, crustaceans, bivalves, and polychaetes and occupy a tertiary consumer level in the food web. Pelagic juveniles prey largely on herbivorous euphausiids and occupy a secondary consumer level in the food web (Love 1991; Smith and Brown 1983). Longspine thornyhead are commonly found in shortspine thornyhead stomachs. Cannibalism of newly settled longspine thornyhead may occur because juveniles settle directly onto adult habitat (Jacobson and Vetter 1996). Sablefish commonly prey on longspine thornyhead.(NMFS 2002).

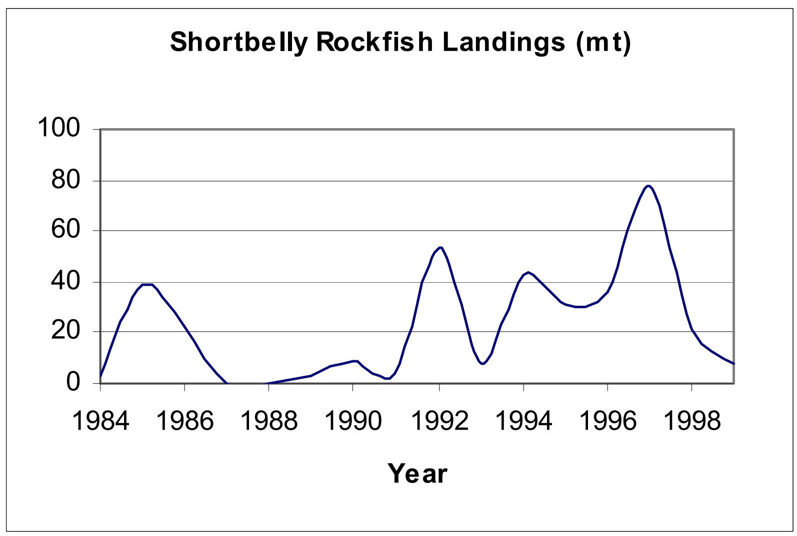
Stock Status and Trends The most recent stock assessment (Rogers *et al.* 1997) indicated longspine thornyheads to be near the target level. There are several uncertainties with the stock assessment. The catch history of longspine thornyheads was difficult to resolve due to lack of species composition information, possible confusion of landed catch with shortspine thornyheads, and different assumptions about discard. The range of uncertainty in the assessment was bracketed by estimating two different catch histories with different assumptions regarding discard rates.

There are currently no fisheries that target shortbelly rockfish.

B.1.2.14 Shortbelly Rockfish (*S. jordani*) occur from La Perouse Bank, southern British Columbia to Punta Baja, southern Baja California. They are most abundant off California and may be the most abundant rockfish in the Council area.

The shortbelly rockfish stock is one of the largest within Council jurisdiction. No directed fishing occurs on this stock, but the stock appears to have declined due to natural causes. The Council sets OY based on the most recently published assessment (Pearson *et al.* 1991).





Most adults are found near the shelf break and sometimes form large mid-water schools.

Distribution and Life History Love *et al.* (2002) and Lenarz (2001) described shortbelly rockfish distribution and life history. Young of the year recruit to the outer edge of kelp beds and deeper waters after spending up to 5 months as pelagic larvae and juveniles in offshore waters. Adults range from bottom depths of 50 fm to 300 fm (91 m to 491 m). Most adults occur near the shelf break at bottom depths between 82 fm to 109 fm (150 m to 250 m). Large adults tend to be in deeper waters than small adults. Adults are semi-pelagic and their behavior is dynamic. They sometimes form large mid-water schools near abrupt drop-offs including edges of submarine canyons. At other times they may be dispersed either in mid-water or on the bottom.

Maximum age of shortbelly rockfish is 32 years. Pearson *et al.* (1991) estimated that the instantaneous rate of natural mortality ranged from 0.2-0.35 (82-75% adult annual survival when there is no fishing mortality). About 50% of 3 year old female shortbelly rockfish are mature off California. Size at age also varies with locality (Pearson *et al.* 1991). Female shortbelly rockfish reach 90% of their maximum size by age 11 years off California. Average size at age of mature females is greater than males. Maximum size is 35 cm (14 in) and 0.4 kg (0.9 lb). Shortbelly rockfish are livebearers. Most larvae are released January through February. Fecundity is dependent on size and ranges from 6,200 to 50,000 eggs.

Natural mortality is fairly fairly high for shortbelly rockfish and maximum age is 32 years.

Little is known about ecological relationships between shortbelly rockfish and other organisms. Small shortbelly rockfish feed primarily on zooplankton such as copepods and young stages of euphausiids. Euphausiids dominate the diet of larger fish. Shortbelly rockfish are an important forage fish. Sea birds, chinook salmon, coho salmon, and marine mammals consume pelagic juveniles. Large fish such as bocaccio and lingcod prey on adults.

Adults primarily feed on krill.

Stock Status and Trends Catches of shortbelly rockfish are minor and most catches are incidental to fishing for other species. Shortbelly rockfish are small and most pass through meshes allowed by regulations. A special permit would be required for a significant fishery to develop. The Council set OY at the low end of estimates of MSY in the most recent assessment (Pearson *et al.* 1991). A more recent study (Ralston *et al. In Press*) indicated that, while still large, biomass may have decreased due to natural causes such as poor ocean conditions (Lenarz *et al.* 1995; MacCall 1996).

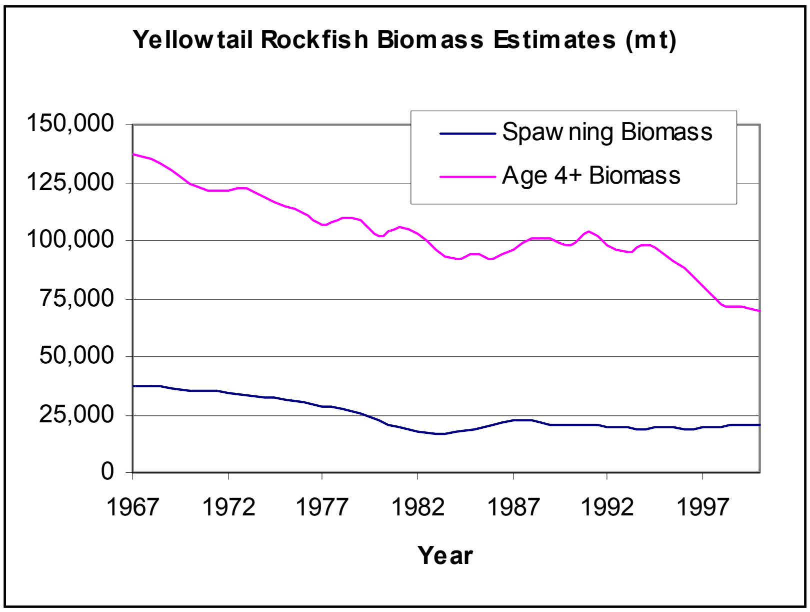
Biomass estimates only apply to a small part of the range.

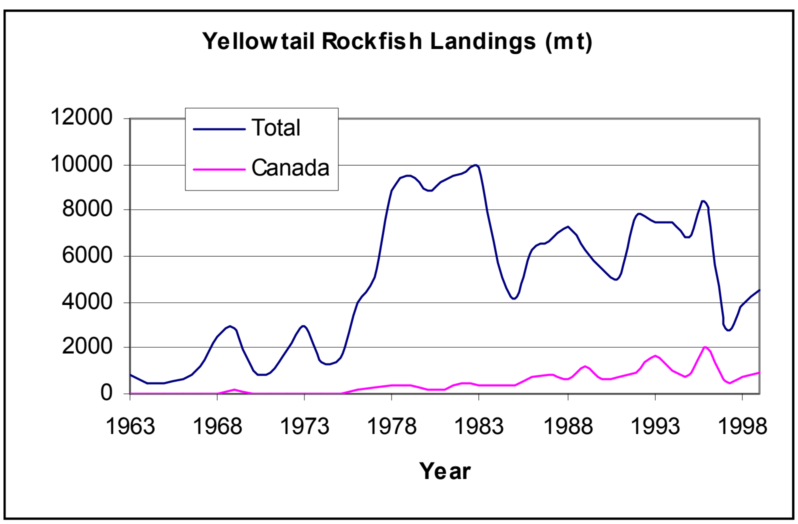
Several factors caused uncertainties in the assessment. The lack of a significant fishery precludes fishery dependent data. Thus there is no experience to base stock productivity on. There have been two types of estimates of biomass: hydro-acoustic and larval production. Both types require unverified assumptions. The biomass estimates only include fish between Monterey and San Francisco. While shortbelly rockfish appear to be most abundant in the assessed area, significant concentrations have been found elsewhere.

Yellowtail rockfish are above the biomass target level.

B.1.2.15 Yellowtail Rockfish (*S. flavidus*) occur from Unalaska Island (Aleutian Islands) to La Jolla, California. They are most abundant from Oregon to British Columbia and are one of the most abundant rockfish in the Council area.

The Council first recommended regulations for yellowtail rockfish (as part of the *Sebastes* complex) in 1983 and regulations specific to yellowtail rockfish in 1985. The most recent assessment (Tagart *et al.* 2000) indicated that there has been a long term decline in biomass, but the stock remains above the target level.





Distribution and Life History Love *et al.* (2002) and Ralston

(2001) described yellowtail rockfish distribution and life history. Young of the year recruit to shallow nearshore waters after spending up to 5 months as pelagic larvae and juveniles in offshore waters. Adults range from the surface to bottom depths of 300 fm (549 m). Most adults occur over the lower shelf at bottom depths between 49 fm and 98 fm (90 m and 180 m). Adults are semi-pelagic and their behavior is dynamic. They often form large mid-water schools. At other times they may be on the bottom. The large aggregations usually occur above bottom features known to fishermen.

Maximum age of yellowtail rockfish is 64 years. Tagart *et al.* (2000) estimated that the instantaneous rate of natural mortality was about 0.11 (90% adult annual survival when there is no fishing mortality), but that mortality of mature females increased with age. Age of maturity varies with locality. Tagart (1991) found that 50% of 9-10 year old female yellowtail rockfish were mature off northern California - southern Oregon, and 50% of 11 year old fish were mature off northern Washington. Size at age also varies with locality (Hart 1973; Tagart *et al.* 1997). Female yellowtail rockfish reach 90% of their maximum size by age 16 years off n. Washington and by age 13 years off n. California-s. Oregon. Average size at age of mature females is greater than males, and size at age has decreased since 1987. Maximum size is 70 cm (28 in) and 5.2 kg (11.5 lb). Tagging results showed that most adults appear to remain near the area of release, but some move as far as 1,400 km (757 miles). Yellowtail rockfish are livebearers. Most larvae are released January through March. Fecundity is dependent on size and ranges from 56,900 to 1,993,000 eggs.

> Most adults are found over the lower shelf and sometimes form large mid-water schools.

> Natural mortality is fairly low and maximum age is 64 years.

Little is known about ecological relationships between yellowtail rockfish and other organisms. Pelagic juveniles feed on planktonic organisms such as copepods. Adults are often caught with other fish such as canary, redstripe and widow rockfish. Midwater animals such as euphausiids and small fish dominate the diet of adult fish. Sea birds and chinook salmon consume pelagic juveniles. Little is known about predation of adults.

> Adults feed on midwater organisms such as small fish and krill.

Stock Status and Trends Catches of yellowtail rockfish were modest until large trawlers began exploiting large schools in 1976. Landings by the unregulated fishery rapidly increased to 9,508 mt in 1979. Biologists documented that the stock was being impacted. Regulations were implemented in late 1983, but landings were still high, 9,864 mt. The Council recommended more restrictive regulations in 1985 and landings

> There are considerable uncertainties in the assessments.

have fluctuated between 2,323 to 6,822 mt since then. The stock is estimated to be close to target levels.

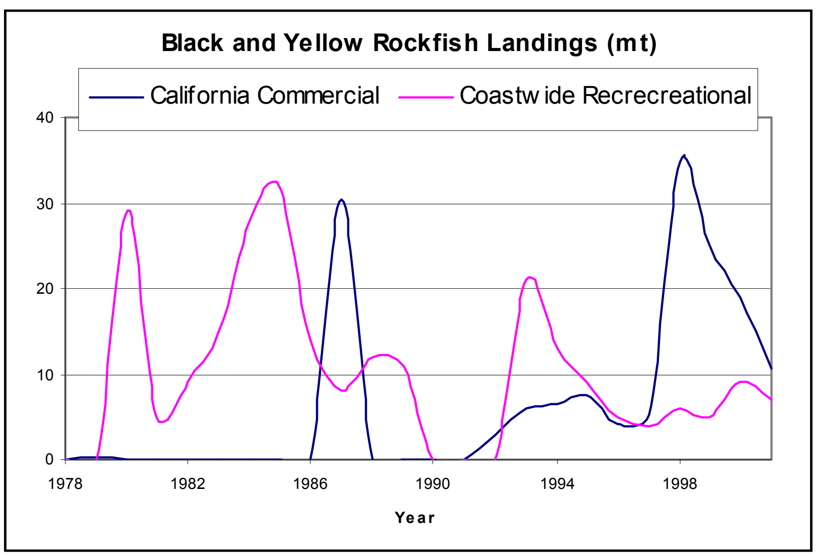
There are two major uncertainties in the assessments. The assessment model estimate of current biomass is very sensitive to results of the most recent trawl survey biomass index. The index undergoes considerable and poorly understood survey to survey fluctuations. Population structure of yellowtail rockfish is controversial. Some research indicates that there is one coastwide stock. Other research suggests that there are several stocks. The current assessment assumes that there is one stock from northern California to southern Canada. Management boundaries are placed at Cape Mendocino, California and the US-Canada border. There is no agreement with Canada about management of the stock that is assumed to be shared between the two countries. The Cape Mendocino boundary is based on the fishery rather than scientific evidence of stock structure.

The stock is estimated to be close to the target level.

B.1.2.16 Black and Yellow Rockfish (*S. chrysomelas*) occur from the Cape Blanco, Oregon to Isla Natividad, central Baja California. They are most abundant from Sonoma County, California to Point Conception, California.

The stock of black and yellow rockfish is abundant but has not been formally assessed. California has regularly sampled commercial landings. Commercial landings were restrained after 1998 because the Council recommended more restrictive commercial regulations for poorly known species.

Most adults are on the upper shelf.



Distribution and Life History Love *et al*. (2002) and Larson and Wilson-Vandenberg (2001) described black and yellow rockfish distribution and life history. Young of the year settle in shallow water after a short pelagic stage. The recently settled fish are mostly found close to fronds of giant and bull kelp. As they grow, they move down the kelp stipes to the bottom and inhabit the same type of rocky nearshore bottom as adults. Adults range to bottom depths of 20 fm (37 m). Most adults occur on the upper shelf at bottom depths less than 6.6 fm (12 m). Adult fish tend to be solitary and on the bottom. They defend territories and studies revealed very little movement.

Maximum age is about 30 years.

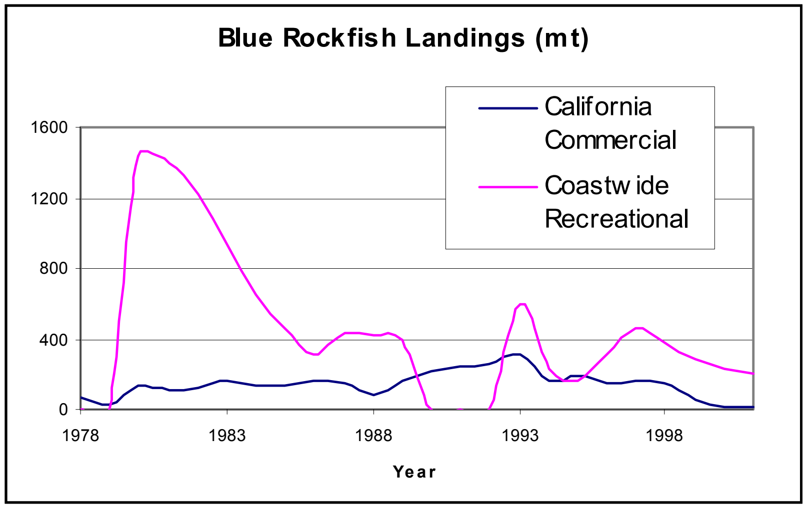
Maximum age of black and yellow rockfish is about 30 years. Mature male and females of the same age are about the same size. Female black and yellow rockfish are mature by 27 cm (11 in). Fish mature at a smaller size off southern California. Maximum size is 39 cm (15 in). Black and yellow rockfish are livebearers, and parturition extends from January to July. A 26 cm (10 inch) fish from central California had about 425,000 eggs.

Not much is known about ecological relationships between black and yellow rockfish and other organisms. Researchers have observed adults on the same reefs as blue, gopher, kelp, and olive rockfishes, and treefish. Adults mainly consume bottom organisms such as crabs, and shrimp. They also consume small fish, such as sculpins and juvenile rockfish, and cephalopods. Juveniles feed on planktonic crustaceans such as barnacle larvae. Researchers have not documented predation of china rockfish by other organisms.

Stock Status and Trends The status of black and yellow rockfish within the Council's jurisdiction is not known. They are a component of nearshore recreational and commercial catches and demand a premium price.

Blue rockfish have not been assessed.

B.1.2.17 Blue Rockfish (*S. mystinus*) occur from at least Sitka Strait, southeast Alaska to Punta Santo Tomas, northern Baja California. They have been reported north to the Bering Sea, but the northern fish may have been misidentified dusky rockfish. They are most abundant from Eureka, California to the northern Channel Islands, California.



The blue rockfish stock is abundant but has not been formally assessed. California has regularly sampled commercial landings. Blue rockfish are a member of the other rockfish category. The Council recommends regulations for other rockfish as an aggregate. Commercial landings were lower after 1998 because the Council recommended more restrictive commercial regulations for poorly known species.

Distribution and Life History Love *et al*. (2002) and Reilly (2001b) described blue rockfish distribution and life history. Young of the year settle in nearshore waters after a 3-5 month pelagic stage. At first they are often found in the surface canopies of bull or giant kelp or on rock bottoms and have been found in tidal pools. Soon after, almost all of the young descend to rocky bottoms. With further growth they move up into the water column during the day and continue to use rocky bottoms for shelter during the night. Adults range to bottom depths of 300 fm (549 m). Most adults occur over the upper shelf at bottom depths less than 49 fm (90 m). Adult and subadult fish are usually found in or near the kelp forest or offshore reefs, and can form large aggregations that extend to the surface. Tagging studies revealed that most adult blue rockfish moved very little if at all. One tagged fish moved 24 km (1 mile).

Maximum age of blue rockfish is 44 years.

Maximum age of blue rockfish is 44 years. Fifty percent of female blue rockfish are mature by 28 cm (11 in) when they are 6 years old. Females tend to be larger than males of the same age. Maximum size is 53 cm (21 in). Blue rockfish are livebearers. Parturition peaks in January. Fecundity is not well known. A 40.5 cm (16 in) female had 525,000 eggs.

Adults primarily feed on offshore macroplankton and occasionally on algae.

Because of the abundance and availability of blue rockfish for observation in nearshore waters, probably more is known about ecological relationships between blue rockfish and other organisms than for any other groundfish. Researchers have observed adults associated with olive, rosy, starry, and yellowtail rockfish. Juvenile blue rockfish mainly feed on planktonic micro-crustacea and larvaceans. In some years the young are extremely abundant in nearshore waters. A study documented that predation of larvae by young of the year blue rockfish can significantly reduce recruitment of barnacles to the intertidal zone. Adults mostly feed on offshore macroplankton such as pelagic tunicates, scyphozoans, hydromedusae, and, in El Niño years, may consume pelagic red crabs. Blue rockfish also consume squid and young of the year rockfish when available. Even nearshore fish primarily consume offshore macroplankton when there are onshore currents. At other times they may consume considerable amounts of algae. In years of high recruitment, juvenile blue rockfish are a major prey item in nearshore waters. They are consumed by kelp greenling, lingcod, various rockfishes (included adult blue), harbor seals, and sea birds. Lingcod, harbor seals, sea lions, and occasionally larger rockfish such as bocaccio consume adult blue rockfish.

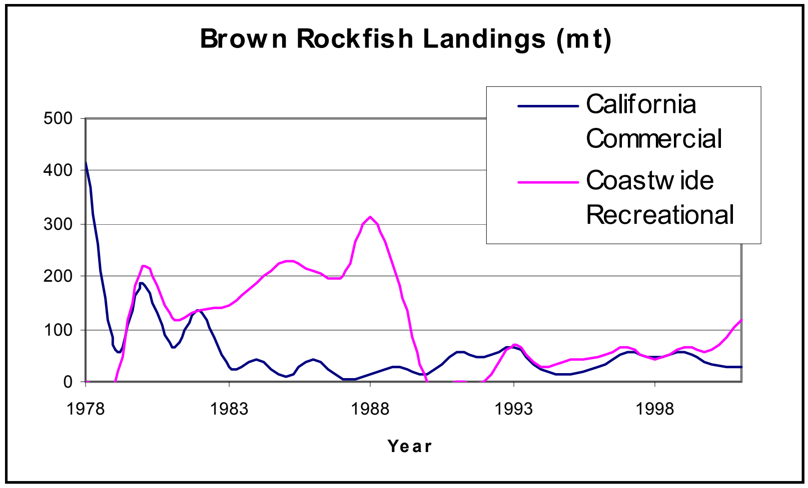
Most adults are on the upper shelf.

Stock Status and Trends The status of blue rockfish is not known. They are an important component of California recreational catches and are sometimes targeted by commercial fishers. CDFG biologists have expressed concerns about decreases in average size and abundance of the species (Reilly 2001b).

Brown rockfish have not been assessed.

B.1.2.18 Brown Rockfish (*S. auriculatus*) occur from Prince William Sound, Alaska to Bahia San Hipolito, southern Baja California. They are most abundant in Puget Sound, Washington and from Bodega Bay, California to Bahia Tortugas, southern Baja California.

The stock of brown rockfish is abundant but has not been formally assessed. California has regularly sampled commercial landings. Brown rockfish are a member of the other rockfish category. The Council recommends regulations for other rockfish as an aggregate. Commercial landings were lower after 1998 because the Council recommended more restrictive commercial regulations for poorly known species.



Distribution and Life History Love *et al*. (2002) and Ashcraft and Heisdorf (2001) described brown rockfish distribution and life history. Young of the year settle in shallow water to 20 fm (36 m) after a 3 month pelagic stage. They tend to be found over rocks, in pieces of drift algae on the bottom, and on walls of submarine canyons. Adults range to bottom depths of 74 fm (135 m). Most adults occur over the upper shelf at bottom depths less than 66 fm (120 m). Juveniles, subadults, and to a much lessor degree adults are common in estuaries such as San Francisco Bay. Adult and subadult fish tend to be solitary, are usually within a few meters of the bottom and over bottoms of both low and high relief or occasionally associated with eelgrass or other vegetation . Tagging studies revealed that subadults can move from San Francisco Bay to as far as 50 km (31 miles) away along the outer coast. Genetic studies indicate that fish in Puget Sound were distinct from offshore fish.

Maximum age is at least 34 years.

Maximum age of brown rockfish is at least 34 years. Fifty percent of female brown rockfish are mature by 24-31 cm (9.5-12 in) when they are 4-5 years old. Mature females are about the same size as males of the same age. Maximum size is 56 cm (22 in). Brown rockfish are livebearers. Parturition extends from December to August, with two peaks off central and northern California (December-January and May-June). Fecundity is size dependent and ranges from 42,500 to 339,000 eggs..

Adults primarily feed on crabs and fish.

Not much is known about ecological relationships between brown rockfish and other organisms. Researchers have observed adults associated with calico, canary, copper, quillback, and vermillion rockfish. Juvenile brown rockfish mainly feed on small crustaceans. Subadults consume shrimp, small fish, and , when available herring eggs, in San Francisco Bay. Adults mainly consume crabs and fish in offshore waters.

Chinook salmon and harbor seals prey on small brown rockfish.

Stock Status and Trends The status of brown rockfish is not known. They are an important component of nearshore recreational and commercial catches, and command a premium price. NOAA Fisheries Service recently reviewed a petition to list the species under the ESA and determined that listing was not warranted.

Calico rockfish have not been assessed.

B.1.2.19 Calico Rockfish (*S. dallii*) occur from San Francisco, California to Bahia de Sebastian Vizcaino, central Baja California. They are most abundant south of Point Arguello, central California. The stock is abundant but has not been formally assessed.

Most adults are on the upper shelf.

Distribution and Life History Love *et al*. (2002) and Ono (2001) described calico rockfish distribution and life history. Young of the year settle onto soft, sand-rock, or low-lying hard bottom at depths between 11 fm and 23 fm (20 m and 42 m). Adults occur to bottom depths of 140 fm (256 m) and are most common on the upper shelf between 33 fm and 66 fm (60 m and 120 m). Calico rockfish are usually on or near the bottom and are solitary or in small groups.

Maximum age is at least 12 years.

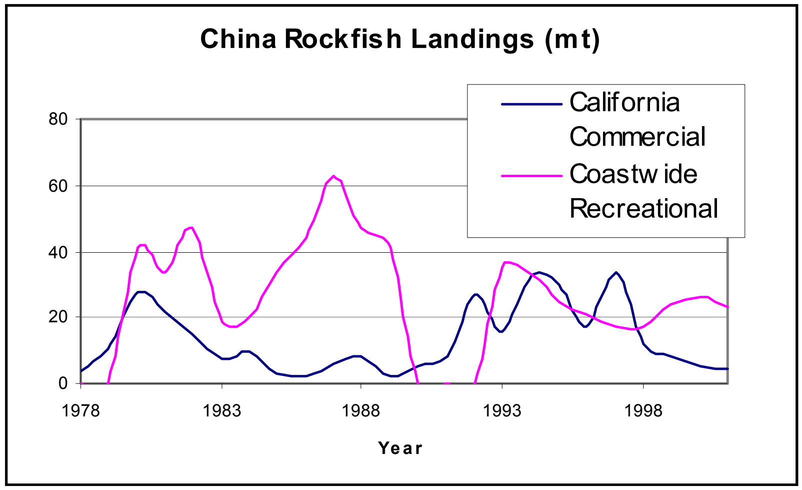
Maximum age of calico rockfish is at least 12 years. Maximum size is 20 cm (8 in). About 50 % of 9 cm (3.5 in) fish are mature. Calico rockfish are livebearers. Parturition occurs in to January to May with a peak in February. Fecundity ranges between 3,900 and 18,000 eggs.

Adults consume a wide variety of bottom and water column organisms.

Not much is known about ecological relationships between calico and other organisms. Adults consume both water column and bottom dwelling organisms such as bivalves, brittle stars, copepods, crabs, euphausiids, gammarid amphipods, fish larvae, shrimp, and worms. Dolphins, larger fish, and sea birds are known to prey upon young and adult calico rockfish.

China rockfish have not been assessed.

B.1.2.20 China Rockfish (*S. nebulosus*) occur from the Kachemak Bay, Alaska to San Nicolas Island and Redondo Beach, southern California. They are most abundant from Prince William Sound, Alaska to northern California. This is an abundant stock but it has not been formally assessed. California has regularly sampled commercial landings.



Most adults are on the upper shelf.

Distribution and Life History Love *et al*. (2002) and Larson and Wilson-Vandenberg (2001) described China rockfish distribution and life history. Young of the year settle in shallow water after a probably short pelagic stage. Adults range to bottom depths of 70 fm (128 m). Most adults occur on the upper shelf at bottom depths greater than about 5.5 fm (10 m). Adult fish tend to be solitary and on the bottom, and occur in areas high-relief rocky outcrops, often boulder fields with numerous crevices. They defend territories and studies revealed very little movement.

Maximum age of China rockfish is 79 years.

Maximum age of China rockfish is 79 years. Female China rockfish are mature by 30 cm (12 in) when they are 6 years old. Maximum size is 45 cm (18 in). China rockfish are livebearers. Parturition extends from January to August and occurs later off Alaska than California. Fecundity is not known.

Adults feed on brittle stars, chitons, crabs, and other bottom organisms.

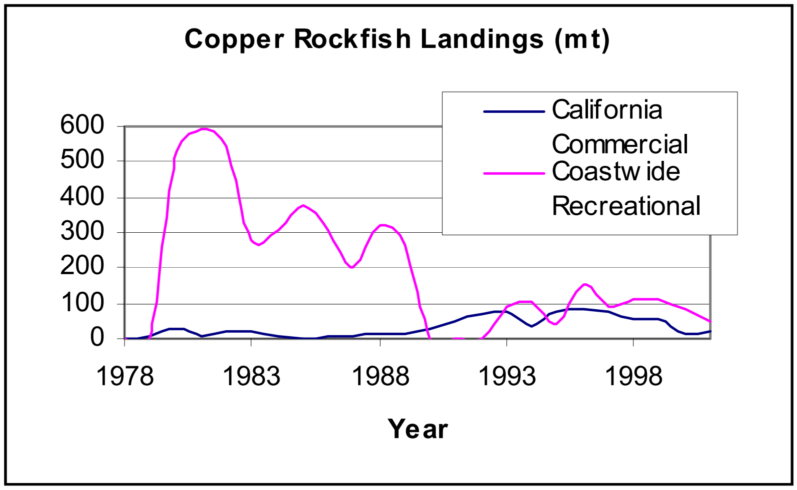
Not much is known about ecological relationships between China rockfish and other organisms. Researchers have observed adults in dens of the large Pacific octopus. Adults mainly consume bottom organisms such as brittle stars, chitons, crabs, nudibranchs, octopuses, red abalone, shrimp, small fishes, and snails. Juveniles feed on planktonic crustaceans such as barnacle larvae. Researchers have not documented predation of China rockfish by other organisms.

Stock Status and Trends The status of China rockfish within the Council's jurisdiction is not known. They are a component of nearshore recreational and commercial catches and demand a premium price.

Copper rockfish have not been assessed.

B.1.2.21 Copper Rockfish (*S. caurinus*) occur from Kachemak Bay, Alaska to Islas San Benito, central Baja California. They are most abundant in Puget Sound, Washington and from Valdez, Alaska to Punta Banda, northern Baja California.

The stock of copper rockfish is abundant but has not been formally assessed. California has regularly sampled commercial landings. Copper rockfish are a member of the other rockfish category. The Council recommends regulations for other rockfish as an aggregate. Commercial landings were lower after 1998 because the Council recommended more restrictive commercial regulations for poorly known species.



Most adults are on the upper shelf.

Distribution and Life History Love *et al*. (2002) and Lea (2001) described copper rockfish distribution and life history. Young of the year settle in shallow water after a short pelagic stage. They often settle within kelp or eelgrass beds. If a canopy exists, the young occur near the surface, otherwise they are closer to the bottom. The young fish then settle to the bottom after a few months. Adults range to bottom depths of 100 fm (183 m). Most adults occur over the upper shelf at bottom depths less than 49 fm (90 m). Adult and subadult fish tend to be solitary or in small aggregations, are usually within a few meters of the bottom, and occur in boulder fields and over high-relief rocks. Adults are also sometimes found over low relief rocks. Tagging studies revealed very little movement. Genetic studies indicated that fish in Puget Sound were distinct from offshore fish, and there may be distinct groups along the outer coast.

Maximum age is at least 50 years.

Maximum age of copper rockfish is at least 50 years. Fifty percent of female copper rockfish are mature by 34 cm (13.4 in) when they are 6 years old. Mature females are about the same size as males of the same age. Maximum size is 66 cm (26 in). Copper rockfish are livebearers. Parturition extends from January to July over its entire range with southern fish releasing larvae first. Fecundity is size dependent and ranges from 16,000 to 640,000 eggs.

Adults primarily feed on crabs, shrimp, and fish.

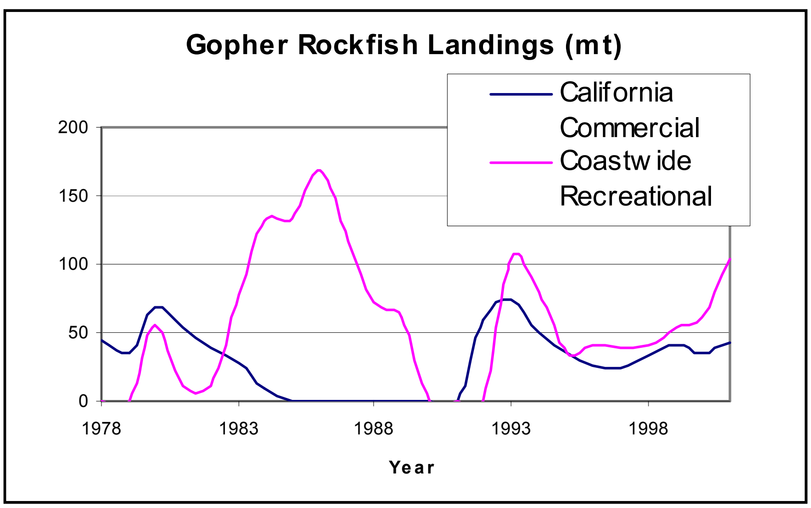
Not much is known about ecological relationships between copper rockfish and other organisms. Researchers have observed adults associated with black, brown, dusky, quillback, silvergrey, tiger, vermillion, and yelloweye rockfish. While near the surface, juvenile copper rockfish mainly feed on copepods and invertebrate larvae. After settling to the bottom, the young fish prey on shrimps and caprellid and gammarid amphipods. Adults mainly consume crabs, shrimp, and fish, but also consume amphipods, mysids, squid, and octopuses. Chinook salmon prey on small copper rockfish.

Stock Status and Trends The status of copper rockfish is not known, but evidence indicates that there have been local depletions (Lea 2001). They are an important component of nearshore recreational and commercial catches. NOAA Fisheries Service recently reviewed a petition to list the species in Puget Sound under the ESA and determined that listing was not warranted.

B.1.2.22 Gopher Rockfish (*S. carnatus*) occur from Cape Blanco, Oregon to Punta San Roque, southern Baja California. They are most abundant from Sonoma County, California to Arrecife Sacramento, Central Baja California.

Gopher rockfish have not been assessed.

Gopher rockfish are abundant but have not been formally assessed. California has regularly sampled commercial landings.



Most adults are on the upper shelf.

Distribution and Life History Love *et al*. (2002) and Larson and Wilson-Vandenberg (2001) described gopher rockfish distribution and life history. Young of the year settle in shallow water after a short pelagic stage. The recently settled fish are mostly found close to fronds of giant and bull kelp. As they grow, they move down the kelp stipes to the bottom and inhabit the same type of rocky nearshore bottom as adults. Adults range to bottom depths of 44 fm (80 m). Most adults occur on the upper shelf at bottom depths greater than 9.8 fm (18 m). Adult fish tend to be solitary and on the bottom. They defend territories and studies revealed very little movement.

Maximum age of gopher rockfish is not known. Female gopher rockfish are mature by 31 cm (12 in). Maximum size is 42.5 cm (17 in). Gopher rockfish are livebearers. Parturition extends from January to July. Fecundity is not known.

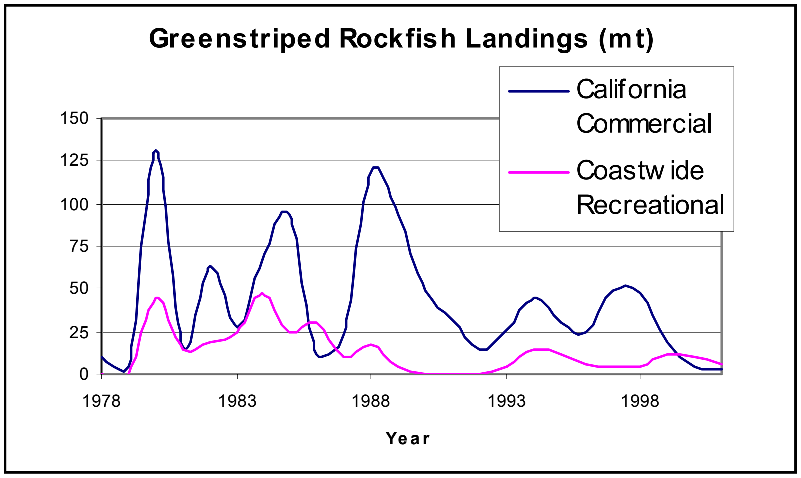
Adults mainly feed on crab and shrimp.

Not much is known about ecological relationships between gopher rockfish and other organisms. Researchers have observed adults on the same reefs as black and yellow, blue, kelp, and olive rockfishes, and treefish. Adults mainly consume bottom organisms such as crabs, and shrimp. They also consume small fish, such as sculpins and juvenile rockfish, and cephalopods. Juveniles feed on planktonic crustaceans such as barnacle larvae. Researchers have not documented predation of China rockfish by other organisms.

B.1.2.23 Greenstriped Rockfish (*S. elongatus*)

occur from Chirikof Island, Aleutian Islands to Isla Guadalupe, central Baja California. They are most abundant from British Columbia to northern Baja California.

Greenstriped rockfish are abundant but have not been formally assessed. Oregon did not report commercial landings before 1987 and recreational landings were not reported before 1980 and between 1990 and 1992.



Most adults are on the lower shelf and upper slope.

Distribution and Life History Love *et al*. (2002) described greenstriped rockfish distribution and life history. Young of the year settle to the bottom in water deeper than 40 m (131 ft/ 22 fathoms) after a several month pelagic stage. They are usually found at the interface between fine sand and clay bottoms. Some young of the year are also found within sand and cobblestone patches and sand-mud bottoms that surround rock outcrops. They move into deeper water as they mature. Adults range from bottom depths of 6.6 fm to 71 fm (12 m to 495 m). Most adults occur on the lower shelf and upper slope at bottom depths between 55 fm to 137 fm (100 m to 250 m). Adults are usually solitary and on cobble, rock rubble, or mud bottom. They also occur in boulder fields and other high relief areas.

Maximum age is 54 years.

Maximum age of greenstriped rockfish is 54 years. Fifty percent of females off Oregon and Washington are mature by 22 cm (8.7 in) when they are 7 years old. Female tend to be larger than males of the same age. Maximum size is 43 cm (17 in). Greenstriped rockfish are livebearers. Parturition occurs January through July, primarily April through May. Fecundity is dependent on size and ranges from 11,000 to 295,000 eggs. Females off southern California release two broods per year, but northern fish only release one.

Adults feed on krill, fish and many other planktonic and benthic organisms.

Little is known about ecological relationships between greenstriped rockfish and other organisms. Researchers have observed adults associated with cowcod, greenblotched, greenspotted, halfbanded, pygmy, stripetail, and swordspine rockfish. Adults feed on euphausiids, fish, shrimp, calanoid copepods, squid, and gammarid amphipods. Chinook salmon prey on small greenstriped rockfish.

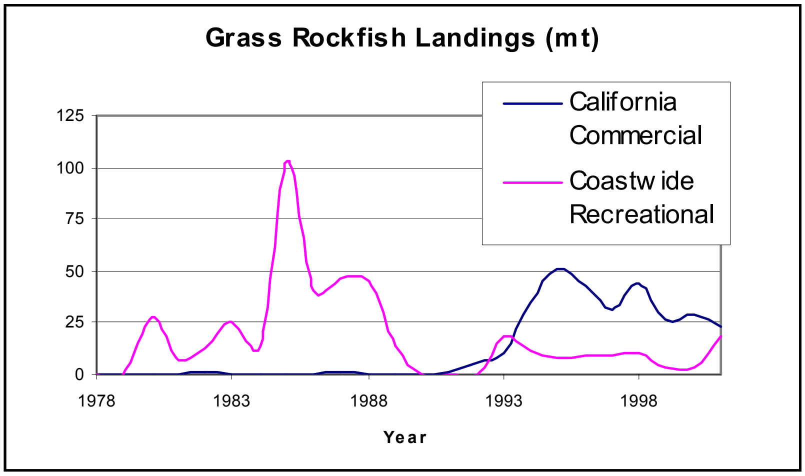
Stock Status and Trends The status of greenstriped rockfish is not known. Fishers do not target them because of their small size. Many that are caught by both commercial and recreational fishers are discarded because of their small size.

Grass rockfish have not been assessed.

B.1.2.24 Grass Rockfish (*S. rastrelliger*) occur from Yaquina Bay, Oregon to Bahia Playa Maria, central Baja California. They are most abundant from southern Oregon to about Bahia San Quintin, northern Baja California.

Adults are on the upper shelf.

The stock of grass rockfish is abundant but has not been formally assessed. California has regularly sampled commercial landings. Grass rockfish are a member of the other rockfish category. The Council recommends regulations for other rockfish as an aggregate. Commercial landings were restrained after 1998 because the Council recommended more restrictive commercial regulations for poorly known species.



Distribution and Life History Love *et al*. (2002) and Larson and Wilson-Vandenberg (2001) described grass rockfish distribution and life history. Adults are occasionally caught in San Francisco Bay. Young of the year settle in shallow water after a short pelagic stage. Adults and sub-adults occur on the upper shelf at bottom depths less than 25 fm (46 m). Some adults are found in tide pools. Adult fish tend to be on the bottom of rocky reefs.

Maximum age is at least 23 years.

Maximum age of grass rockfish is at least 23 years. Mature male and females of the same age are about the same size. All female grass rockfish are mature by 33 cm (13 in). Fish mature at a smaller size off southern California. Maximum size is 56 cm (22 in). Grass rockfish are livebearers. Parturition extends from January to March. Fecundity ranges from 80,000 to 760,000 eggs.

Adults mainly feed on bottom organisms such as crab and shrimp.

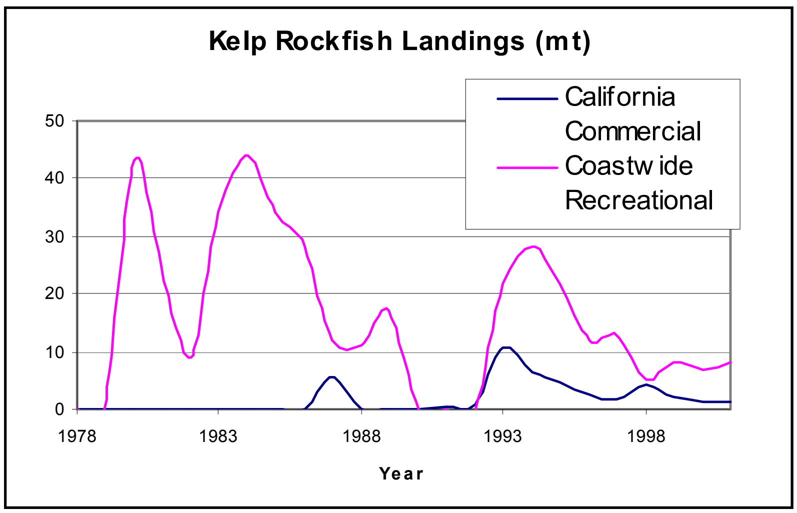
Not much is known about ecological relationships between grass rockfish and other organisms. Adults mainly consume bottom organisms such as crabs, gammarid amphipods, isopods, snails and pistol shrimp. They also consume small fish, such as seaperch and midshipmen. Juveniles feed on planktonic crustaceans such as barnacle larvae. Researchers have not documented predation of grass rockfish by other organisms.

Stock Status and Trends The status of grass rockfish within the Council's jurisdiction is not known. They are an important component of nearshore recreational and commercial catches and demand a premium price, especially as live fish.

Kelp rockfish have not been assessed.

Most adults live in kelp forests.

B.1.2.25 Kelp Rockfish (*S. atrovirens*) occur from Albion, northern California to Bahia San Carlos and Islas San Benitos, central Baja California. They are most abundant from central California to Arrecife Sacramento, central Baja California. They have not been formally assessed. California has regularly sampled commercial landings.



Maximum age is at least 25 years.

Adults mainly feed on both canopy and bottom dwelling organisms.

Distribution and Life History Love *et al*. (2002) and Larson and Wilson-Vandenberg (2001) described kelp rockfish distribution and life history. Young of the year settle in shallow water after a short pelagic stage. After settlement this species is usually found in kelp forests and range from canopy to bottom. However adults occur bottom depths of 32 fm (58 m). Young fish sometimes occur in the tidal zone. Adult fish tend to be solitary but aggregations of up to 50 fish occur.

Maximum age of kelp rockfish is at least 25 years. Mature male and females of the same age are about the same size. All female kelp rockfish are mature by 34 cm (13 in). Maximum size is 42.5 cm (17 in). Kelp rockfish are livebearers.

Parturition extends from February to June. Fecundity ranges from 10,000 to 275,000 eggs.

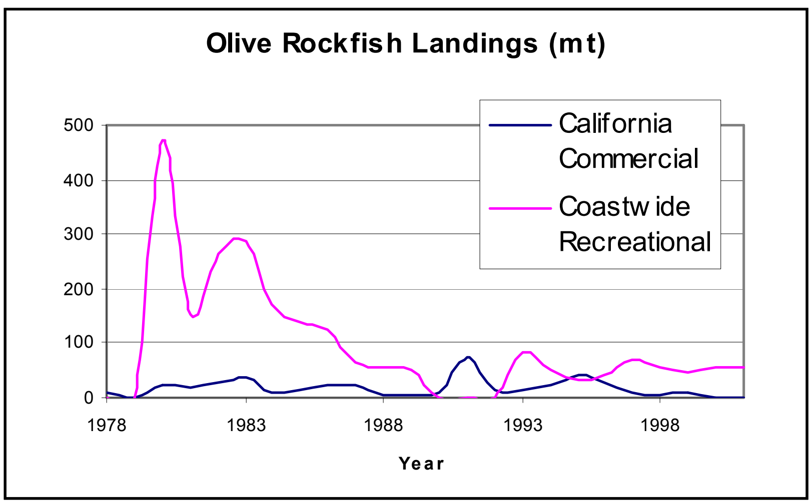
Not much is known about ecological relationships between kelp rockfish and other organisms. Adults occur on the same reefs as black and yellow, blue, gopher, and olive rockfish. Adults consume both bottom and canopy dwelling organisms such as small crustaceans typical of the kelp canopy, crabs, bottom shrimp, and fish eggs. They also consume small fish, such as young of year rockfish, kelp fish, pricklebacks, and sculpins. Juveniles feed on planktonic crustaceans such as barnacle larvae. Researchers have not documented predation of kelp rockfish by other organisms.

Stock Status and Trends The status of kelp rockfish within the Council's jurisdiction is not known. They are an important component of nearshore recreational and commercial catches.

Olive rockfish have not been assessed.

Most adults are on the upper shelf.

B.1.2.26 Olive Rockfish (*S. serranoides*) occur from southern Oregon to Islas San Benitos, central Baja California. They are most abundant from Cape Mendocino, California to the northern Channel Islands, southern California. They not been formally assessed. California has regularly sampled commercial landings.



Distribution and Life History Love *et al*. (2002) and Love (2001) described brown rockfish distribution and life history. Young of the year settle in nearshore water as shallow as 1.6 fm (3 m) after a pelagic stage. They are associated with kelp beds, oil platforms, surfgrass, and other structures. During the day they are in the water column and seek shelter at night among rocks or under algae. Adults range to bottom depths of 94 fm (172 m). Most adults occur over the upper shelf at bottom depths less than 66 fm (120 m). Adult and subadult fish are often in the water column over high relief bottom and form small to moderate sized schools. Tagging studies revealed that olive rockfish can move as far as 33 km (20 miles), but usually do not move much.

Maximum age is at least 30 years.

Maximum age of olive rockfish is at least 30 years. Fifty percent of female olive rockfish are mature by 33-35 cm (13-13.8 in) when they are 5 years old. Females tend to be larger than males of the same age. Maximum size is 61 cm (24 in). Olive rockfish are livebearers. Parturition extends from December to March, with a peak in January. Fecundity is size dependent and ranges from 30,000 to 490,000 eggs.

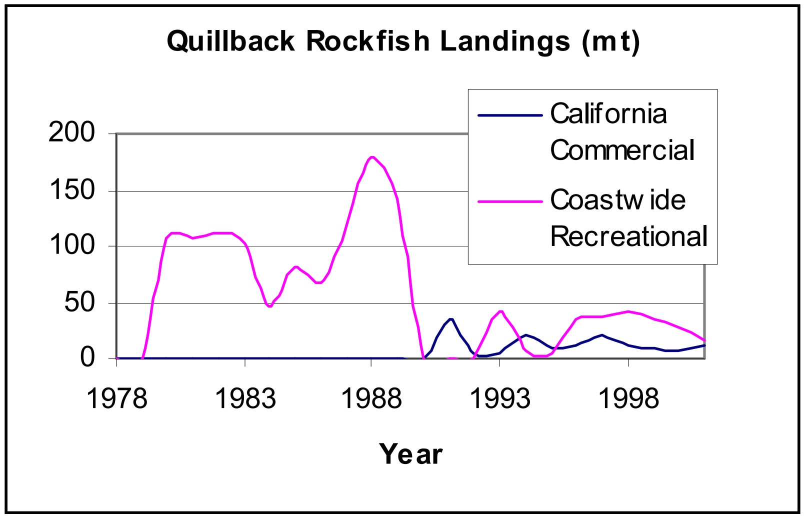
Adults consume many types of organisms including small fish squid, and polychaete worms.

Not much is known about ecological relationships between olive rockfish and other organisms. Researchers have observed adults in the same habitat as black and yellow, blue, copper, gopher, and kelp rockfish. They are sometimes caught with yellowtail rockfish off northern California. Juvenile olive rockfish mainly feed on small planktonic crustaceans and fish larvae. Older fish consume small fish such as juvenile rockfish, squid, octopuses, isopods, polychaete worms, and euphausiids, (and pelagic red crabs during El Niños). Researchers have not documented predators of olive rockfish.

Stock Status and Trends The status of olive rockfish is not known. They are not important in the commercial fishery. They were a significant component of the southern California recreational fishery, but their abundance has considerably decreased in the southern range. The decrease may be due to a shift in the ocean climate that began about 1976 and/or fishing.

Quillback rockfish have not been assessed.

B.1.2.27 Quillback rockfish (*S. maliger*) is a shelf rockfish. The species has not been formally assessed but is believed to be abundant. California has regularly sampled commercial landings.



Most adults are on the upper shelf.

Distribution and Life History Love *et al*. (2002) and Osorio and Klingbeil (2001) described quillback rockfish distribution and life history. Quillback rockfish occur from the Kenai Peninsula, Alaska to Anacapa Passage, southern California. They are most abundant in Puget Sound, Washington; Strait of Georgia, Canada; and along the outer coast from southeast Alaska to northern California. Young of the year settle in shallow water after a short pelagic stage, and are sometimes associated with detached plant material on sandy bottoms. Adults range to bottom depths of 150 fm (274 m). Most adults occur on the upper shelf at bottom depths less than about 55 fm (100 m). Adult fish tend to be solitary and on the bottom, and occur in areas of high-relief broken rock. Adults sometimes rise into the water column to feed on fish and may form small schools in the process. Tagging studies revealed very little movement. Genetic studies indicated that fish in Puget Sound were distinct from offshore fish.

Maximum age is 95 years.

Maximum age of quillback rockfish is 95 years. Fifty percent of female quillback rockfish are mature by 29 cm (11.4 in) when they are 11 years old. Mature females are about the same size as males of the same age. Maximum size is 61 cm (24 in). Quillback rockfish are livebearers. Parturition extends from April to July. Fecundity is not known.

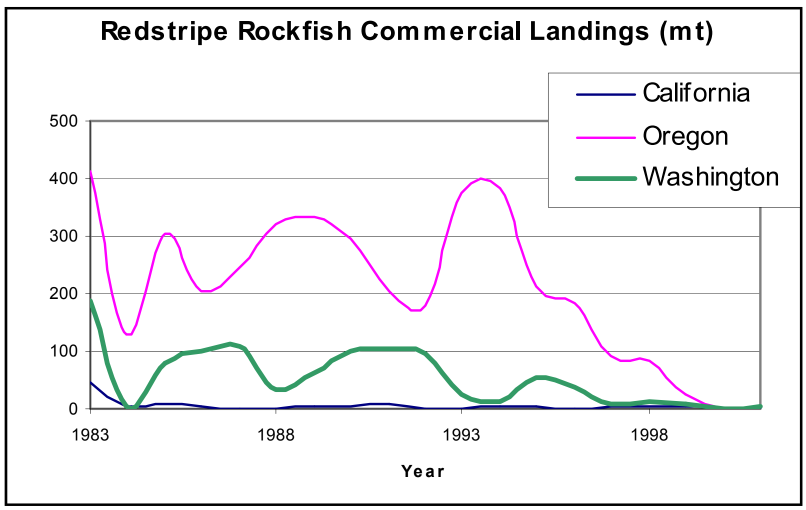
Adults feed on crabs, shrimp, amphipods, isopods, and fish.

Not much is known about ecological relationships between quillback rockfish and other organisms. Researchers have observed adults associated with copper, and quillback rockfish. Adults mainly consume bottom organisms such as crabs, shrimp, amphipods, and isopods, and sometimes rise in the water column to prey on fish. Juveniles are consumed by larger rockfishes, lingcod, cabezon, salmon, sea birds, and marine mammals. Adults are subject to predation by larger fish, sea lions, and seals.

Stock Status and Trends The status of quillback rockfish within the Council's jurisdiction is not known. They are an important component of nearshore recreational and commercial catches. The NMFS reviewed a petition to list the species in Puget Sound under the ESA and determined that listing was not warranted.

Redstripe rockfish have not been assessed.

B.1.2.28 Redstripe Rockfish (*S. proriger*) occur from southeastern Bering Sea and Aleutian Islands to southern Baja California. They are most abundant from southeast Alaska to cental Oregon. The stock of redstripe rockfish is abundant but has not been formally assessed.



Most adults are over or on the lower shelf and upper slope.

Distribution and Life History Love *et al*. (2002) described redstripe rockfish distribution and life history. Adults range from bottom depths of 7 fm to 232 fm (12 m to 424 m). Most adults occur over or on the lower shelf and upper slope at bottom depths between 82 fm to 150 fm (150 m to 275 m). Adults are semi-pelagic and are associated with high relief bottom. They may be on or near the bottom as individuals, small groups or sometime schools. Off British Columbia they apparently sometimes form dense schools by day and then rise and disperse at night.

Maximum age is at least 55 years.

Maximum age of redstripe rockfish is at least 55 years. Fifty percent of females off Oregon and Washington are mature at 28 cm (11 in) when they are 7 years old. Mature females are larger at a specific age than males. Maximum size is 51 cm (20 in). Redstripe rockfish are livebearers. Parturition occurs April to July.

Adults primarily feed on krill, shrimp, and small fish.

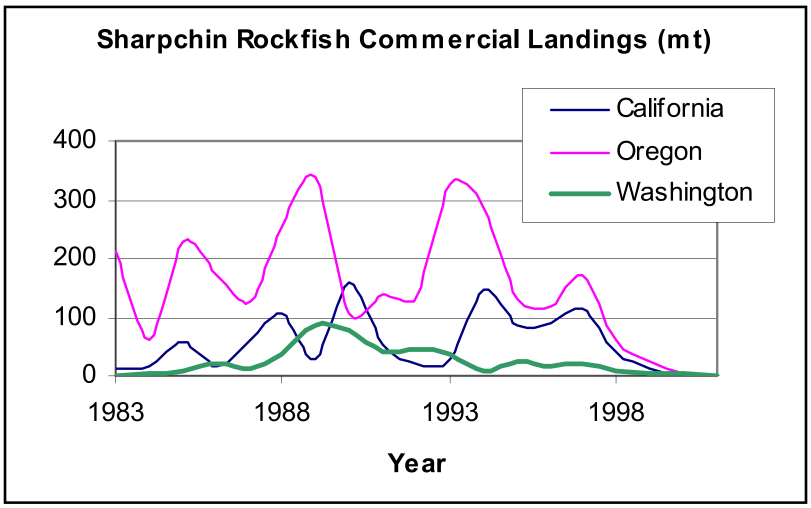
Little is known about ecological relationships between splitnose rockfish and other organisms. Adults are often caught with Pacific Ocean Perch and yellowmouth rockfishes and sometimes with widow rockfish. Researchers have observed them with harlequin, sharpchin, and yelloweye rockfish. Euphausiids, shrimp, and small fish dominate the diet. Chinook salmon consume them.

Stock Status and Trends The status of redstripe rockfish is not known. They are often caught by midwater trawls. Recreational fishers seldom capture redstripe rockfish. Because of its longevity, populations of the species probably can only support low rates of exploitation.

Sharpchin rockfish have not been assessed.

B.1.2.29 Sharpchin Rockfish (*S. zacentrus*)

occur from Attu Island, Aleutian Islands to San Diego, California. They are most abundant from the Gulf of Alaska to northern California. The stock has not been formally assessed.



Distribution and Life History Love *et al*. (2002) described sharpchin rockfish distribution and life history. Adults range from bottom depths of 14 fn to 271 fm (25 m to 495 m). Most adults occur over or on the lower shelf and upper slope at bottom depths between 55 fm and 164 fm (100 m and 300 m) over cobble-mud or boulder-mud bottoms. Fish size tends to increase with depth. Small fish have been observed in vase sponges and among dense fields of crinoids. Fish are usually on or near the bottom and often in small groups. They sometimes school.

Most adults are over or on the lower shelf and upper slope.

Maximum age of sharpchin rockfish is at least 58 years. Maximum size is 45 cm (18 in). Fifty percent of females off Oregon and Washington are mature at 22 cm (8.7 in) when they are 6 years old. Sharpchin rockfish are livebearers. Parturition occurs March to July, and appears to be latter towards the north.

Maximum age is at least 58 years.

Little is known about ecological relationships between sharpchin rockfish and other organisms. Adults are often caught with Pacific Ocean Perch and darkblotched, splitnose and yellowmouth rockfishes Euphausiids, shrimp, amphipods, copepods, and small fish dominate the diet. Researchers have not documented predators of sharpchin rockfish.

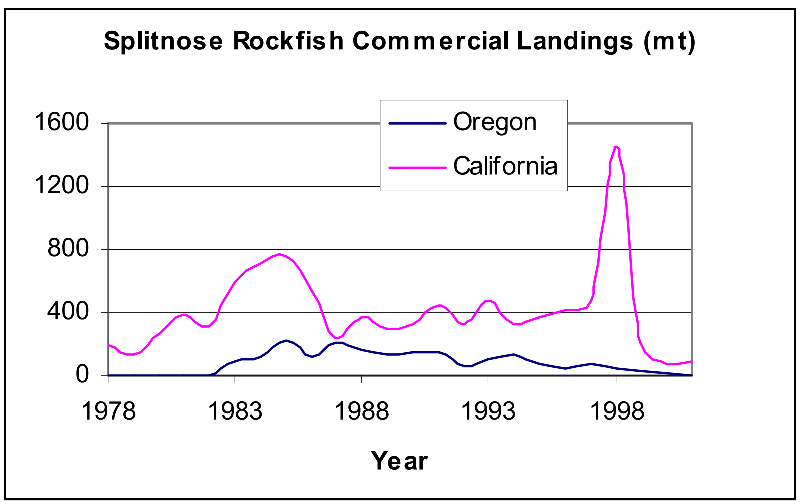
Adults primarily feed on euphausiids, shrimp, amphipods, copepods, and small fish.

Stock Status and Trends The status of sharpchin rockfish is not known. They are often caught by bottom trawl. Recreational fishers seldom capture sharpchin rockfish. Because of its longevity, populations of the species probably can only support low rates of exploitation.

B.1.2.30 Splitnose Rockfish (*S. diploproa*)

Splitnose rockfish are an upper slope species. Adults occur over or on the bottom, sometimes forming large mid-water schools.

occur from Prince William Sound, Alaska to Isla Cedros, central Baja California. They are most abundant from British Columbia to southern California. The stock has not been formally assessed. California and Oregon have regularly sampled commercial catches. Splitnose rockfish are a member of the other rockfish category. The Council recommends regulations for other rockfish as an aggregate. Catches were lower after 1998 because the Council recommended more restrictive regulations for poorly known species.



Distribution and Life History Love *et al*. (2002) described splitnose rockfish distribution and life history. Young of the year spend at least a few months near the surface often associated with drifting vegetation. They then begin a slow transition moving deeper in the water column until they reach the bottom near the end of their first year. Adults range from bottom depths of 50 to 435 fm (91 m to 795 m). Most adults occur over or on the upper slope at bottom depths between 118 fm to 191 fm (215 m to 350 m). Large adults tend to be in deeper waters than small adults. Adults are semi-pelagic. Solitary individuals often are observed on low-relief mud fields near isolated rock, cobble, or shell debris. These individuals often create shallow depressions for shelter. Splitnose rockfish sometimes form large mid-water schools up to 55 fm (100 m) off the bottom.

Maximum age is 86 years.

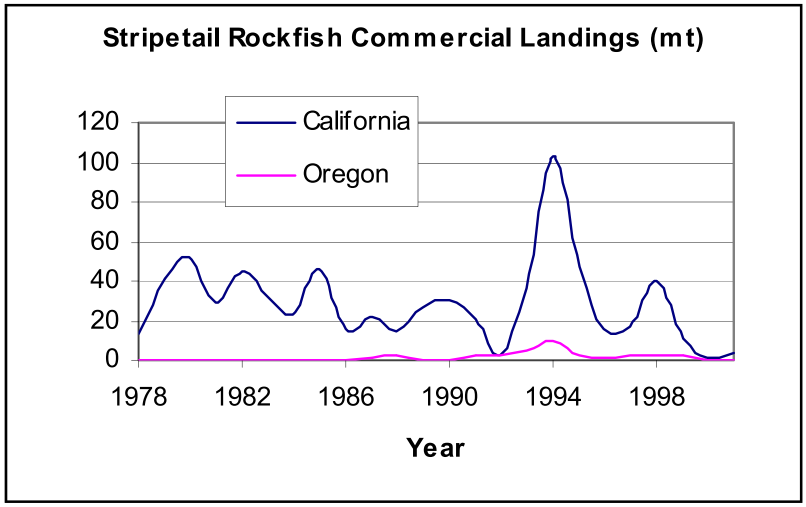
Maximum age of splitnose rockfish is 86 years. Female splitnose rockfish off California are mature at 18-23 cm (7-9 in) when they are 6-9 years old. Female reach a longer length and grow faster than males. Maximum size is 46 cm (18 in). Splitnose rockfish are livebearers. Parturition occurs January through September, primarily in July, off central California. Fecundity is dependent on size and ranges from 14,000 to 255,000 eggs.

Adults primarily feed on krill.

Little is known about ecological relationships between splitnose rockfish and other organisms. Adults are often caught with Pacific Ocean Perch, darkblotched, sharpchin, and yellowmouth rockfishes. Pelagic juveniles feed primarily on zooplankton such as calanoid copepods and amphipods. Euphausiids dominate the diet of benthic juveniles and adults fish. The larger fish also consume copepods, sergestid shrimp, and amphipods. Steller sea lions and other pinnipeds prey on splitnose rockfish (probably juveniles or small adults).

Stock Status and Trends The status of splitnose rockfish is not known. The fish are very spinney, produce low fillet yields, and market demand is often limited. They are often caught incidently to fishing directed at other species, but at times there has been a directed fishery on large aggregations found off central California. Recreational fishers seldom capture splitnose rockfish. Because of its longevity, populations of the species probably can only support low rates of exploitation.

B.1.2.31 Stripetail rockfish (*S. saxicola*) is a shelf rockfish. The species has not been formally assessed but is believed to be abundant. Oregon did not report landings before 1987.



Distribution and Life History Love *et al* (2002) described stripetail rockfish distribution and life history. Stripetail rockfish occur from Yakutat Bay, Alaska to Bahia Sebastian Vizcaino, central Baja California. They are most abundant from British Columbia to southern California. Young of the year settle to nearshore benthic habitats after a several month pelagic stage. They are often found in pieces of drift algae or other bottom debris on sandy bottoms. Some are found in kelp beds and over cobblestones. They gradually move into deeper water as they mature. Adults range from bottom depths of 14 fm (25 m) to 299 fm (547 m). Most adults occur on the lower shelf at bottom depths between 55 fm (100 m) to 109 fm (200 m). Large adults tend to be in deeper waters than small adults. Adults often are on low-relief mud or mud and scattered small rock bottoms. They can be abundant on shell mounds surrounding deep oil platforms. Stripetail rockfish usually are on or within a few meters of the bottom.

Maximum age is at least 38 years.

Maximum age of stripetail rockfish is at least 38 years. Female stripetail rockfish off California are mature by 18 cm (7 in) when they are 4-9 years old. Females tend to be larger than males of the same age. Maximum size is 41 cm (16 in). Stripetail rockfish are live bearers. Parturition occurs November through March, primarily December through February. Fecundity is dependent on size and ranges from 15,000 to 230,000 eggs.

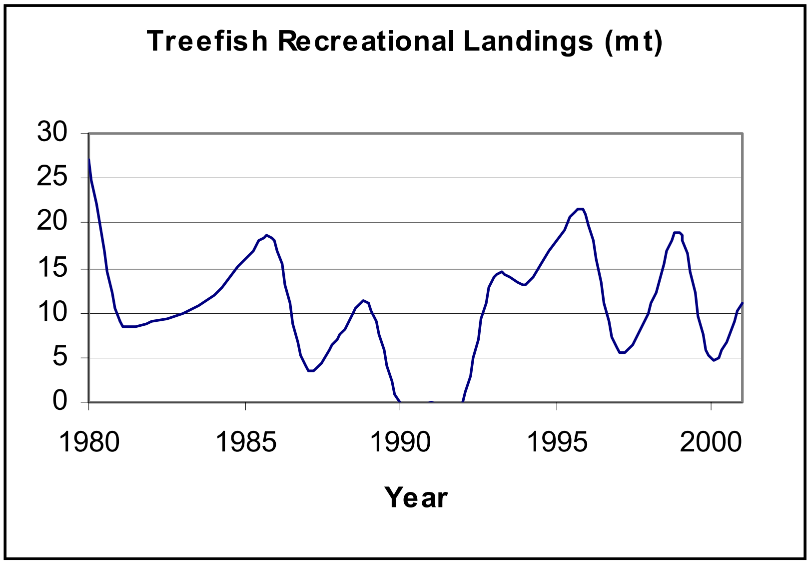
Adults primarily feed on euphausiids and copepods.

Little is known about ecological relationships between stripetail rockfish and other organisms. Adults are often found in the same habitat as greenstriped, splitnose rockfishes, Dover sole, poachers, and/or thornyheads. Euphasiids and copepods dominate the diet of adults. Chinook salmon prey on stripetail rockfish.

Stock Status and Trends The status of stripetail rockfish is not known. Fishers do not target them because of their small size. Most landed stripetail rockfish are females; male stripetail rockfish may be too small to be retained by commercial trawls. Recreational fishers seldom capture stripetail rockfish.

Treefish have not been assessed.

B.1.2.32 Treefish Rockfish (*S. serriceps*) are a shelf species that occurs from San Francisco, California to Isla Cedros, central Baja California. They have not been formally assessed.



Distribution and Life History Love *et al*. (2002) and Larson and Wilson-Vandenberg (2001) described treefish distribution and life history. Young of the year occur under drifting kelp mats and then settle to bottom at depths between 5 fm and 8 fm (9 m and 15 m). Adults occur on the upper shelf to bottom depths of 49 fm (90 m) and are most common in waters less than 33 fm (60 m). Treefish inhabit crevices and caves of high relief bottoms and are territorial.

Maximum age is at least 23 years.

Maximum age of treefish is at least 23 years, and they grow to 41 cm (16 in). Parturition occurs in to June and July. Fecundity of a 28.5 cm female was 70,000 eggs.

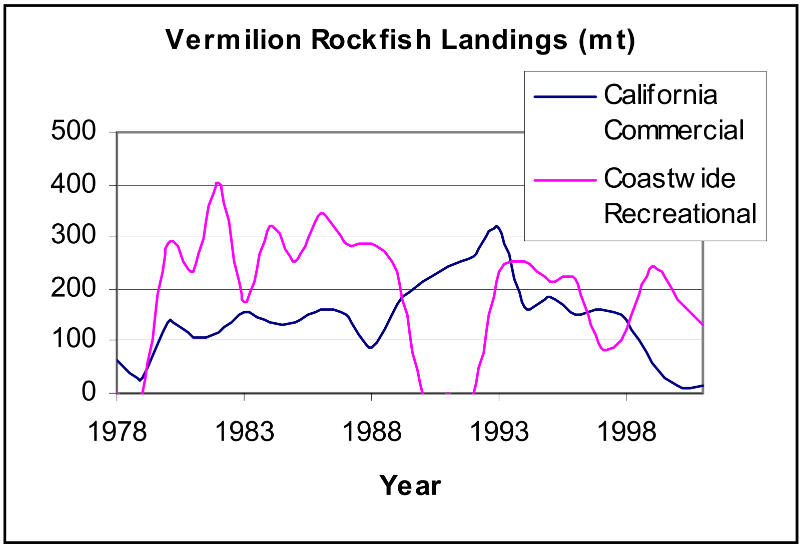
Adults eat bottom dwelling organisms such as crab, fish and shrimp.

Not much is known about ecological relationships between treefish and other organisms. Adults occur on the same reefs as black and yellow, gopher, and kelp rockfish. Adults eat bottom dwelling organisms such as crab, fish, and shrimp. Least terns prey on young treefish.

Stock Status and Trends The status of treefish within the Council's jurisdiction is not known. They are an important component of nearshore recreational catches. The southern California nearshore live fish fishery also takes treefish.

B.1.2.33 Vermilion Rockfish (*S. miniatus*) occur from Prince William Sound, Alaska to Islas San Benito, central Baja California. They are most abundant from northern California to northern Baja California. The stock has not been formally assessed.

Most adults are on the mid shelf.



Distribution and Life History Love *et al*. (2002) described vermilion rockfish distribution and life history. Young of the year settle to waters 3-20 fm (6-36 m) deep after a several month pelagic stage. They are usually found hovering near sand patches adjacent to structures such as worm tubes and pier pilings or the interface of sand and hard substrata. They tend to move into deeper water as they mature. Adults range from bottom depths of 3 fm to 238 fm (6 m to 436 m). Most adults occur on the mid shelf at bottom depths between 27 fm to 82 fm (50 m to 150 m). Adult and subadult fish usually aggregate on high relief bottoms. Solitary fish are sometimes found in shallow-water caves and crevices.

Maximum age is at least 60 years.

Maximum age of vermilion rockfish is at least 60 years. Fifty percent of vermilion rockfish are mature by 37 cm (14.5 in) when they are 5 years old. Female tend to be larger than males. Maximum size is 76 cm (30 in) and 6.8 kg (15 lbs). Vermilion rockfish are livebearers. Parturition occurs July through March, primarily November, off southern California, and September-June off central and northern California. Fecundity is dependent on size and ranges from 63,000 to 2,600,000 eggs.

Adults feed on small fish and squid, krill, octopus, and many other planktonic and benthic organisms.

Little is known about ecological relationships between vermilion rockfish and other organisms. Researchers have observed adults associated with blue, bocaccio, brown, canary, copper, and yellowtail rockfish. Adults feed on small fish, squid, euphausiids, and octopuses. They also take salps, pelagic red crabs, shrimp, copepods, mysids, amphipods, isopods, and polychaetes. Sea birds prey on small vermilion rockfish.

Stock Status and Trends The status of vermilion rockfish is not known. Both recreational and commercial fishers value them.

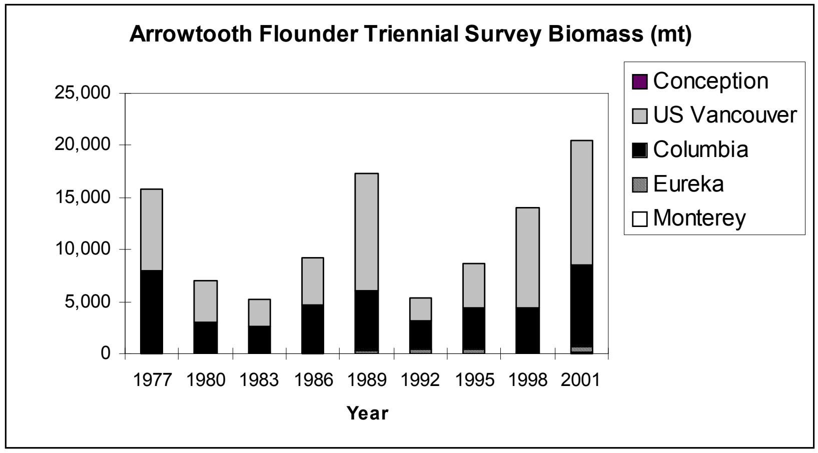
B.1.3 Flatfish

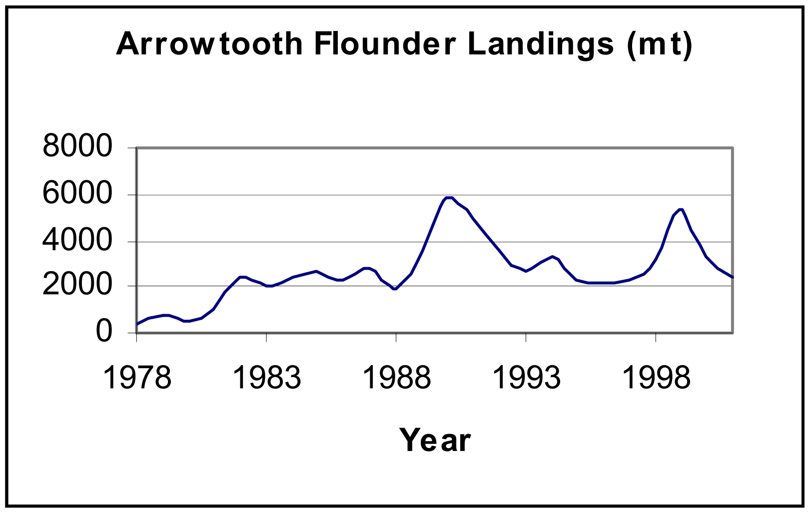
B.1.3.1 Arrowtooth Flounder (*Atheresthes stomias*)

ranges from the Bering Sea to coast off San Pedro, California, although it is more common offshore from Alaska to British Columbia (Eschmeyer *et al.* 1983).

Biomass appears to be highly variable - Arrowtooth flounder are at the southern end of their range in the Pacific region.

Although abundant within the northern part of the Columbia and Vancouver areas, historical catches were low until the past two decades. Flesh quality has generally been considered poor, but new markets and improved handling have increased demand for this trawl caught species.





Distribution and Life History Arrowtooth flounder ranges from the Chukchi Sea and Bearing Sea to southern California off San Pedro. It is more common offshore from Alaska to B.C. It is one of the right-eyed flounders and lives on soft bottom habitat from 10 to 400 fm (18-731 m). It is characterized by a large jaw and long and rather sharp teeth. State sampling programs have collected length and age data since 1986. They can reach lengths of up to 84 cm (Eschmeyer *et al.* 1983). Growth completion rates range from 0.140 to 0.156 for females and 0.312 to 0.348 for males. Length at 50% maturity was estimated to be 37.3 cm for females and 27.8 cm for males. Arrowtooth flounder are difficult to age and ages have not been validated. Assigned ages ranged from 3 to 27 years.

Stock Status and Trends Beginning in the 1980s, landings of arrowtooth flounder gradually increased to resent averages of around 3,500 mt. Discarding of arrowtooth is thought to be substantial over the catch history. Landed as mink food in the 1950s and 1960s, catches declined in the 1970s. The last stock assessment on arrowtooth flounder was conducted in 1993

(Rickey 1993) for the U.S. portion of the Vancouver and Columbia areas combined. An equilibrium yield per recruit was estimated using a dynamic pool model for females only. Recruitment was assumed to be constant with no spawner-recruit relationship. Model results were used to estimate fishing mortality and exploitation rates.

NMFS survey biomass estimates reviewed in the assessment were highly variable. Arrowtooth in the assessed area are at the southern end of their range and the variability may have been due to environmental factors.

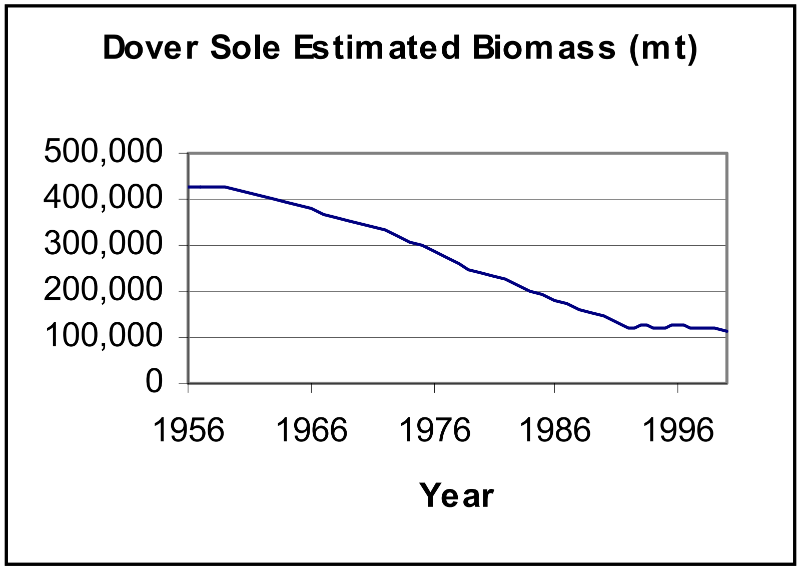
A joint U.S. and Canadian assessment is recommended.

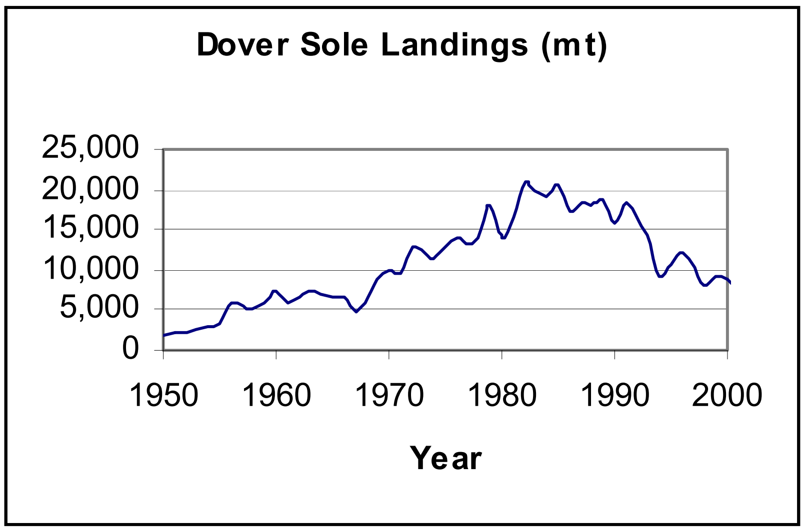
Future assessments should include the Canadian zone. Fishery logbook data indicate that most of the U.S. catch occurs near the U.S.-Canada border. The survey indicates that the biomass is about two times higher in the surveyed portion of the Canadian zone than in U.S. waters. Catch in Canada increased greatly in 1990 and was nearly 50% of the U.S. catch in 1992 (PFMC 2000).

Dover sole are at 29% of pristine biomass.

B.1.2.2 Dover Sole (*Microstomus pacificus*) is a deep water flatfish that ranges from northern Baja California to the Bering Sea and inhabits depths up to 800 fm (Kramer *et al.* 1995). This commercially important flatfish species has been the target of trawl operations along the west coast of North America since before World War II. Coastwide catches peaked in 1980s, exceeding 20,000 mt.

The most recent stock assessment for Dover sole completed in 2001 indicates current spawning stock size to be about 29% of the unexploited biomass (Sampson and Wood 2002). Recent recruitments have been lower than average.





Distribution and Life History Dover sole are generally found on mud or muddy-sand deeper than 20 fm (37 m) and out to 750 fm (1,372 m). They feed on polychaete worms, pink shrimp, brittle stars, gammarid amphipod, and small bivalves (Gabriel and Pearcy 1981; Pearcy and Hancock 1978). Stomach content analysis from trawl survey samples indicate polychaete worms as the dominant food item (Buckley *et al.* 1999).

Dover sole are found on mud or sandy mud bottom types, deeper than 20 fm and out to 750 fm.

Dover sole may reach 40 years in age.

Dover sole live to a maximum age of about 40 years, with females attaining a maximum length of 55-60 cm, about 5-10 cm longer than males. The sex ratio in the landed catch is almost 50:50, with males predominating at lengths less than about 38 cm, females predominating at greater lengths, and males being slightly dominant overall. Based on research survey tows, Jacobson and Hunter (1993) found that the catches of Dover sole in a given area and depth zone were not randomly distributed by sex, with males and females tending to occur in separate patches. Furthermore, Dover sole undergo ontogenetic shifts in their distribution with fish gradually moving to deeper water as they age and grow (Sampson and Wood 2002).

Dover sole have an extended pelagic larval phase that can last over one year. Larval dispersal is considered to be extensive due to the extended larval phase and the influence of Pacific Coast currents. Recruitment is probably correlated to variation in current patterns and ocean regime shifts. Adult Dover sole are relatively sedentary with no evidence of extensive latitudinal movements. They do, however, make seasonal migrations from the continental slope to the shelf in the spring and back to the slope in the fall to spawn.

Dover sole are managed as part of the Council's Dover sole, thornyhead, and sablefish (DTS) complex.

Dover sole are managed as part of the Council's Dover, thornyhead, and sablefish (DTS) complex. Other important species associations in the catch include Pacific ocean perch and dark blotched rockfish on the continental slope , and shelf rockfish, other flatfish, and ocean shrimp (*Pandalas jordani*) on the continental shelf.

Spawning biomass was expected to increase from 1997 through 2000 due to an exceptionally strong 1991 year-class. This was confirmed in the most recent assessment.

Stock Status and Trends The 1997 Dover sole stock assessment treated the entire population from the Monterey area through the U.S./Vancouver area as a single stock based on recent research addressing the genetic structure of the population. The assessment author generated projections of spawning biomass and expecting landings for 1998 to 2000 under a variety of harvest policies and three recruitment scenarios. The hypothetical harvest policies ranged from an immediate reduction to the $F_{45\%}$ harvest rate to an increase up to the $F_{20\%}$ harvest rate. In all cases, for each of the low, medium, and high projected recruitments, the expected spawning biomass increased from the estimated year-end level in 1997 through the year 2000 due to growth of the exceptionally large 1991 year class and to the lower catches observed in the fishery since 1991 (PFMC 2002b).

The most recent Dover sole in 2001 indicated current spawning stock size to be about 29% of the unexploited biomass (Sampson and Wood 2002). Recent abundances appear to be without trend, but were preceded by a steady decline since the late 1950s. The last strong year class was the one produced in 1991, which confirms the findings of the 1997 assessment. Poor ocean conditions associated with the El Niños in the 1990s have likely affected Dover sole recruitment. The 2001 assessment authors projected five years of Dover sole harvest levels based on preferred, optimistic, and pessimistic

Recent ocean conditions may have produced a series of poor recruitments.

projections of recruitment. These options varied the harvest rate from $F_{40\%}$ (the current F_{MSY} proxy) to $F_{50\%}$.

The size-sex distributions of Dover sole vary between areas and have changed over time. Major uncertainties with the assessment and stock status are related to size-related discarding or differences in selection due to gear or depth of fishing. These effects are confounded in the fishery size-composition data.

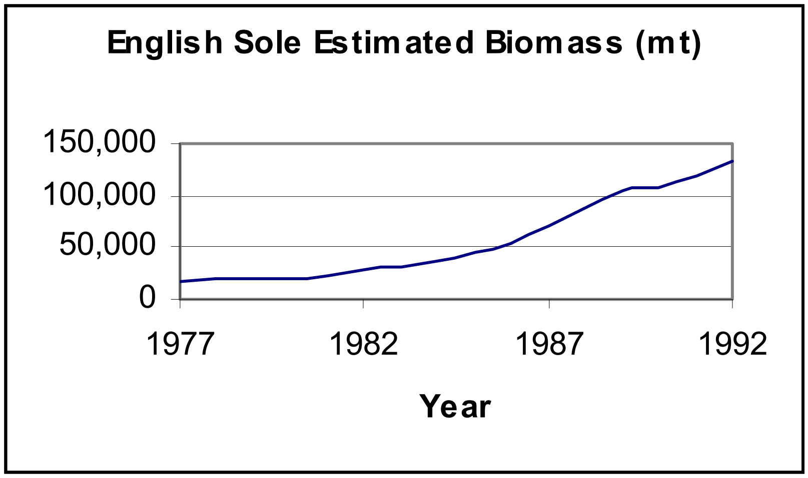
English sole biomass is above target levels and increasing.

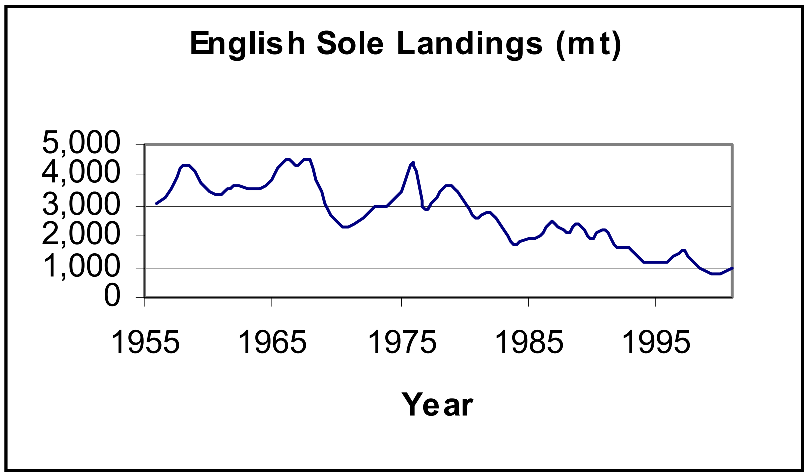
B.1.2.3 English Sole (*Parophrys vetulus*) are found in relatively shallow water (less than 300m) from Baja California to the Gulf of Alaska (Miller and Lea 1972). Although English sole are not as highly prized as other flatfish such as petrale sole, or landed in as large quantities as Dover sole, the abundance of this resources and its proximity to the shore have made English sole an important component of the trawl fishery off Oregon and Washington since this fishery began just prior to World War II.

The most recent stock assessment completed in 1993 (Sampson and Stewart 1993) indicated nearly a 7-fold increase in biomass since the 1970s to about 133,000 mt. The large biomass is attributed to strong recruitment and relatively low exploitation rates. Current catch levels are well below ABC.

During the 1950s and 1960s, flatfish dominated landings of groundfish exceeding 50% of the landed weight (Fishery Statistics of the US, 1950-69). In the 1980s and 1990s, rockfish became the dominant landings of groundfish (PacFIN). Recent restrictions on rockfish will likely reverse this trend and inshore flatfish species like English sole may again become a more important component of the landed catch if bycatch of overfished species can be minimized.

English sole are found over sandy bottom habitat in shallow water.





Distribution and Life History Spawning occurs offshore in waters shallower than 100 m, primarily during the autumn and winter, but the timing is variable (Kruse and Tyler 1983). Although spawning occurs on the bottom, the eggs are buoyant and rise to the surface and hatch about seven days after spawning. The planktonic larvae metamorphose, settle to the bottom, and assume their demersal form about two months after hatching (Kruse and Tyler 1983). The 0-age fish occur in estuaries and in shallow waters along the open coast (Krygier and Pearcy 1986). As the fish grow they move into deeper water where the adult population is found. English sole are generally found on sandy substrate (Demory *et al.* 1976), and juveniles and adults feed largely on polychaetes and amphipods (Kravitz *et al.* 1976).

English sole exhibit sexual dimorphism with the females attaining a greater sizes than males. The size difference in English sole is so great that landings of English sole are almost exclusively female fish.

English sole may reach ages in excess of 20 year and females are nearly all mature after age 4. Stock assessments have used a natural mortality coefficient between 0.26 and 0.294 per year.

Stock Status and Trends. English sole, like Dover and petrale sole, have been the target of trawl operations along the west coast of North America since before World War II. Almost all of the harvests have been taken by groundfish trawl. Since 1956 the reported landings of English sole off the US West Coast have been relatively stable, ranging from a peak of 4,539 mt in 1968 to a low of 1,678 mt in 1984. The landings in recent years have generally been below average.

The increase in English sole biomass is attributed to recent strong recruitments and low exploitation rates.

The most recent assessment addressed English sole in US Vancouver and Columbia areas (northern stock). An age-structured version of the Stock Synthesis program was applied to female age composition data from the Oregon and Washington trawl fisheries. Since catches were taken at very low rates of fishing, fishery independent auxiliary information were used in the assessment. NMFS survey data on female length composition and the NMFS survey estimates of population abundance (sexes combined) were used to "tune" the stock synthesis model. Biomass appears to be increasing due to a period of strong recruitment and low fishing mortality. Current spawning biomass in the northern range appears to be at an historical high.

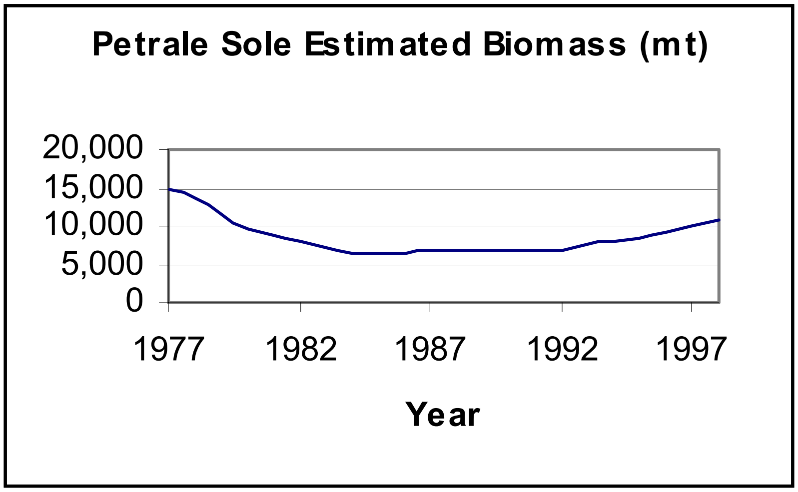
Sensitivity analysis of the base-run model for the northern stock indicated a very low survey catchability coefficient (Q) and unreasonably high level of biomass. The model was also sensitive to assumptions about selectivity. The final model constrained survey Q to 0.35 and allowed for dome-shaped selectivity with time varying selectivity patterns. Uncertainty in the assessment is related to causes of the increase in biomass. The apparent increase is due to either a period of favorable ocean conditions and strong recruitment, or low fishing mortality, or a combination of these factors. Much of the female spawning biomass is unavailable to the gear with current mesh size and fishing practices.

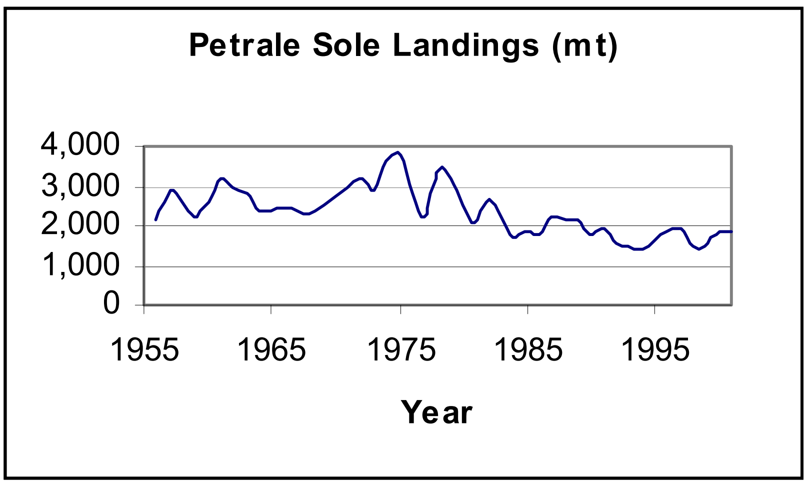
The previous assessment for English sole in the INPFC Conception, Monterey and, Eureka areas (southern stock) was conducted by Jow and Geibel (1985). Their results suggested that the abundance in 1984 was only 30% of the peak estimated abundance of 47 million fish in 1978. The authors estimated MSY to be 1,281 mt, which may be conservative since catches of English sole exceeded this estimate in 55 out of 60 years

(1924-1984). Landings since 1984 in the southern INPFC areas have been well below Jow and Geibel's estimate of MSY.

Petrale sole biomass is thought to be in excess of 39% of pristine levels.

B.1.2.4 Petrale Sole (*Eopsetta jordani*) range from northern Baja California to the Bering Sea and Aleutian Islands (Kramer *et al.* 1995). Petrale sole is a commercially important flatfish species that has been the target of trawl operations along the west coast of North America since before World War II. Current spawning biomass is estimated to be in excess of 39% of pristine spawning biomass.





Stock structure is not well understood. Petrale sole are targeted during the winter months when they aggregate in discrete areas to spawn.

Distribution and Life History Petrale sole are generally found on sand and mud bottoms at depths from about 10 to 300 fm (18-549 m) and feed on euphausids, herring, sand lance and shrimp (Ketchen and Forrester 1966; Kravitz *et al.* 1976). They live to a maximum age of about 20 to 25 years, with females attaining a maximum length of about 60-65 cm, about 20 cm longer than the males. The sex ratio in the landed catch is almost 50:50, with males predominating at lengths less than about 38 cm and females predominating at greater lengths.

Ketchen (1966) estimated natural mortality coefficients to be 0.18-0.26 / yr for males and 0.19-0.21 for females based on catch curve analysis lightly exploited stocks. The most recent stock assessment uses a mortality coefficient of 0.20 / yr for males and females.

Stock structure is not well understood. There are several relatively discrete spawning sites in deep water (150-250 fm) off the US west coast. Spawning occurs from about November through March but seems to be variable among the spawning grounds. Females spawn once per year and fecundity varies with fish size with one large female laying as many as 1.5 million eggs (Porter 1964). Petrale sole eggs are buoyant (Alderdice and Forrester 1971; Ketchen and Forrester 1966) and after hatching the larvae spend their first 5-6 months up in the water column before they metamorphose to their adult form and settle to the bottom (Pearcy *et al.* 1977). No specific areas have been identified as nursery grounds for juvenile petrale sole.

Biomass of petrale sole is stable or increasing and above the target level.

Stock Status and Trends. Petrale sole have been the target of trawl operations along the west coast of North America since before World War II. Almost all of the harvests have been taken by groundfish trawl. Annual landings from US waters averaged 2,600 mt during the 1960s, 3,100 mt during the 1970s, 2,100 mt during the 1980s, and 1,700 mt during the 1990s. For the past several decades, the fishery has been markedly seasonal, with substantial portions of the annual harvest taken from spawning grounds and landed during December and January. Discarding of small, unmarketable fish (5-15%) is an important, but poorly documented feature of the fishery.

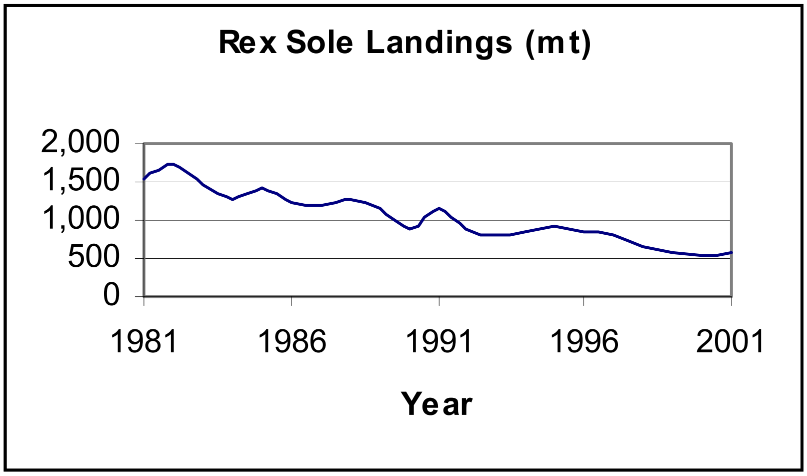
The most recent assessment addressed the northern stock of petrale sole in US Vancouver and Columbia areas (Sampson and Lee 1999). A length-based version of the Stock Synthesis program was used with length and age composition data separated into a winter and summer fishery. Biomass appears to be stable or increasing after an initial fishing down process. Current spawning biomass is estimated to be in excess of 39% of pristine spawning biomass.

Uncertainty in the assessment is associated with inconsistencies in length and age information - especially affected are growth parameters for males.

Sensitivity analysis of the base-run model for the northern stock indicated inconsistencies among the age and length composition data and the underlying models for growth, particularly for the males - contributing to uncertainty in the assessment. No acceptable base-run models were found for the southern stocks of petrale sole in the Eureka and Monterey areas (Sampson and Lee 1999).

Rex sole has contributed significantly to the trawl fishery. Its stock status is unknown.

B.1.2.5 Rex Sole (*Glyptocephalus zachirus*) has been an important flatfish in the trawl fishery since before World War II. Rex sole are distributed from the western Bering Sea to Cedros Island, Baja California. No stock assessment has been done on Rex sole.



Distribution and Life History Rex sole are distributed from the western Bering Sea to Cedros Island, Baja California (Eschmeyer *et al.* 1983; Love 1991; Miller and Lea 1972). They are found from the surface down to 400 fm (732 m) occupying the upper continental slope and shelf. Rex sole is most abundant in water deeper than 200 fm (366 m) (Hart 1973) and prefers muddy-sand bottom. Adult rex sole apparently have a wide bathymetric distribution compared to other flatfish (Hosie 1976). Rex sole is a middle shelf-mesobenthal species, occurring from 0-850 m. In survey catches, most (96%) occurred from 50-450 m (Allen and Smith 1988). Rex sole are probably the most widely distributed sole on the continental shelf and upper slope off Oregon, occupying a large bathymetric range with diverse sediments (Pearcy 1978). They can occur in water as shallow as 18 m (Eschmeyer *et al.* 1983) and occur in Puget Sound (Becker and Chew 1987).

Rex sole move inshore in the summer and make offshore spawning movements in the winter (Love 1991). They undergo a modest ontogenetic movement from the shelf to upper slope habitat (Vetter *et al.* 1994). The maximum movement of a recaptured tagged rex sole was only 54 km, suggesting only limited movement (Hosie and Horton 1977).

Off Oregon young-of-the-year rex sole are most abundant at 200 m (Pearcy 1978). Juveniles (40-60 mm SL) are common in beam trawls on the outer edge of the continental shelf (150-200 m) during winter months off Oregon (Pearcy *et al.* 1977). Rex sole are most abundant from Heceta Bank at 55-150 m and intermediate-sized rex sole (75-150 mm) inhabit shallower water of the inner shelf (Pearcy 1978).

Rex sole can be distinguished from other soles by its long pectoral fin on the eyed side of the body (Hosie 1976).

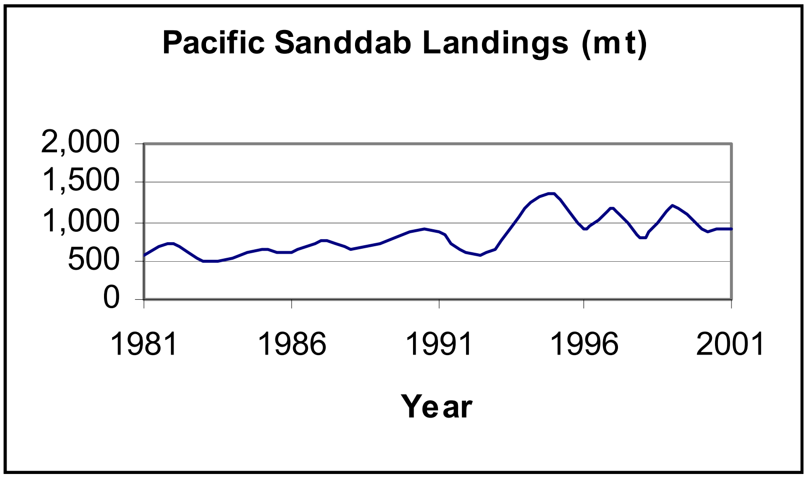
Size and age of first maturity for females is 19 cm at about age four and most females are mature at about 24 cm and 5 years of age. Males begin to mature at 13 cm and at only 2 years of age. They will be fully mature at 10 cm and five years of age (Hosie 1976; Hosie and Horton 1977). Spawning occurs between 50 and 150 fm from January through June with peaks in March and April (Hosie and Horton 1977). The spawning period coincides with the months of peak average surface and subsurface sea temperature (Castillo 1995). Females produce a wide range of eggs depending on size. A 24 cm female produces about 3,900 eggs while a 59 cm female may produce as many as 238,000 eggs (Hosie 1976; Hosie and Horton 1977). After release eggs and fertilization, the eggs rise from the sea bed into the water column, hatch and become pelagic, planktonic larvae. Larvae feed on plankton. After about a year, larvae metamorphose into bottom dwelling juvenile sole approximately 5 cm long. Rex sole grow rapidly and recruit to the trawl fishery at age three when they are about 16 cm long. Adult rex sole feed on small invertebrates including polychaete worms and amphipods. They are known to live at least 23 years (Eschmeyer *et al.* 1983; Love 1991).

Rex sole feed almost exclusively on benthic invertebrates (Pearcy and Hancock 1978; Stull and Tang 1996). Small (<15 cm SL) rex sole feed mainly on amphipods and other crustaceans. Large (15-45 cm SL) rex sole prey chiefly on polychaetes. Rex sole <20 cm SL prey primarily on euphausiids, decapod crab larvae, copepods, *Oikopleura*, and ostracods. Molluscs form only a minor part of rex sole diet. Euphausiids are principal prey only during summer and cumaceans and *Oikopleura* are more common during the winter (Pearcy and Hancock 1978). In Puget Sound they feed primarily on *Capitella* spp. (Becker and Chew 1987). Rex sole are nocturnal feeders (Becker and Chew 1987).

Stock Status and Trends No formal stock assessment has been completed for Rex sole. Catches of Rex sole have been declining gradually since 1980 averaging about 1,000 mt coastwide, annually. Flatfish trawl surveys conducted off the Oregon coast in the early 1970s estimated total biomass to be in excess of 12,247 mt between the Columbia River and Cape Blanco (Demory *et al.* 1976).

Pacific Sanddab stock status is unknown.

B.1.2.6 Pacific Sanddab (*Citharichthys sordidus*) are found from Cape San Lucas, Baja California, to the Bering Sea. In the past, the Pacific sanddab has been only a minor contributor to the trawl fishery. Since the early 1990s, coastwide landings have increased to about 1,000 mt. The fish is considered a delicacy in the San Francisco region and has enjoyed a strong market there for many years (Barss 1976).



Distribution and Life History Sanddabs occur in depths of 5 to 200 fm (9 to 549 m) but are most abundant in 10 to 50 fm (18 to 91 m) on sandy or sandy-mud bottoms (Barss 1976; Garrison and Miller 1982; Hart 1973). Pacific sanddab inhabit the shallow sublittoral zone of Puget Sound (Hart 1973), and the inner continental shelf along the west coast (Alverson *et al.* 1964; Barss 1976; Kravitz *et al.* 1976). Adults are found in estuaries and coastal waters to as deep as 306 m, but highest abundance is in waters <82 fm (150 m) (Hart 1973). Pearcy and Hancock (1978) found that sanddab were most abundant off Oregon and Washington between 37 and 90 m. In Puget Sound, adults may be found to 150 m, but are common in <20 m of water (Garrison and Miller 1982). Barss (1976) reported adult sanddab occur in San Francisco Bay, and Leos (1991)found adults in Monterey Bay.

Pacific sanddab are oviparous and iteroparous, and eggs are fertilized externally (Garrison and Miller 1982). Spawning occurs from late winter through summer, depending on stock and location. In Puget Sound, spawning begins in February and continues through spring, peaking in March and April (Garrison and Miller 1982; Hart 1973). Off California, spawning takes place July through September, peaking in August (Arora 1951; Garrison and Miller 1982). Female sanddab may spawn twice per season (Arora 1951, Garrison, 1982 #1238; Hart 1973).

Over 50% of three year old fish are mature at about 19cm in length. Eggs and larvae are pelagic and drift with currents. Juveniles and adults are demersal (Garrison and Miller 1982). Larvae may be found as far offshore as 724 km in the upper 200 m of the water column (Sakuma and Larson 1995). Juveniles are primarily found in shallow coastal waters, bays and estuaries (Hart 1973).

Sanddabs grow rapidly during the first 4 years of life and more then more slowly thereafter, attaining 22 cm for males and 26 cm for females at age 7. Sanddabs may live to be 12 years of age.

Sanddabs eat a wide variety of food and show a preference for small fish, squid and octopus. Juveniles and adults are carnivorous. Unlike many sympatric species, Pacific sanddab are mainly pelagic feeders; the only evidence of benthic feeding are annelid worms found in stomachs of some specimens (Pearcy and Hancock 1978). The main food items of large sanddab are crab larvae, squids, octopuses and northern anchovy (Pearcy and Hancock 1978). Smaller sanddab eat euphausiids, amphipods, shrimps and some fish (Kravitz *et al.* 1976; Pearcy and Hancock 1978). The diet of the sanddab is determined mainly by food availability; crab larvae are present only in certain months, and fish consumption is higher in the summer months (Pearcy and Hancock 1978). Sanddabs are also known to feed up in the water column at times (Barss 1976).

Stock Status and Trends Surveys conducted off the Oregon coast in the early 1970s estimated total biomass to be in excess of 10,433 mt on the continental shelf between the Columbia River and Cape Blanco (Demory *et al.* 1976). Catches have increased in recent years but remain constrained by markets.

B.1.4 Other Groundfish

Other groundfish species include rockfish, other flatfish, and other fish (sharks, rays, ratfish, morids, grenadiers) not described above. Life history descriptions of these species may be found in the Appendix to Essential Fish Habitat for West Coast Groundfish which was prepared for Amendment 11 to the FMP. This document may be requested from the Council office and is available at on the web site:

http//www.nwr.noaa.gov/1sustfsh/efhappendix/page1.html. Background descriptions of some of the more significant other groundfish provided below area adapted from the EFH appendix.

B.1.4.1 Leopard Shark (*Triakis semifasciata*)

are sought after by both sport and commercial fishers, principally in nearshore areas off the coast of California.

Distribution and Life History Leopard sharks are found from southern Oregon to Baja California, Mexico including the Gulf of California. A neritic species, the leopard shark is most abundant in California bays and estuaries and along southern California beaches. Although they are common in enclosed, muddy bays, other habitats of the leopard shark are flat, sandy areas, mud flats, and bottoms strewn with rocks near rocky reefs or kelp beds. It is common in littoral waters and around jetties and piers. It is also known to congregate around warm-water outfalls of power plants. The leopard shark occurs in polyhaline-euhaline waters.

Leopard sharks are most common on or near the bottom in waters less than 2.2 fm (4 m) deep, but have been caught as deep as 49.8 fm (91 m). Estuaries and shallow coastal waters appear to be used as pupping and feeding/rearing grounds. Neonate pups occur in and just beyond the surf zone in areas of southern California, such as Santa Monica Bay.

Leopard sharks often enter shallow bays and onto intertidal flats during high tides and retreat on ebb tides. Leopard sharks are active during the day, unlike other nocturnal sharks. They may form large nomadic schools that may be mixed with gray or brown smooth hounds or spiny dogfish.

In Elkhorn Slough, most adult leopard sharks leave by June and return by October whereas juveniles are most abundant there during the summer. Tagging studies in San Francisco Bay show most leopard sharks reside in the bay during March-September, but they also occur both inside and outside the bay from October-February.

Leopard sharks are gonochoristic, ovoviviparous, and iteroparous. Fertilization occurs internally and embryogenesis occurs within the female; there is no yolk-sac placenta. Leopard sharks have a gestation period of 10-12 months. Mating occurs soon after the females give birth, primarily in April and May. Coitus occurs while swimming. Females give birth to 7-36 pups from March-August. Young develop inside the mother but do not receive nourishment from her. Leopard sharks are born as juveniles ranging in size from 18-20 cm at parturition. The maximum recorded length of a leopard shark is 180 cm, but with a average growth rate estimated at 1.4 cm per year, most do not exceed 160 cm in length. Females may take 10-15 years to reach maturity, while males may only take 7-13 years. Maximum age is reported to be 30 years.

The leopard shark utilizes several major food sources without depending upon one, and food preference is dependent upon the size of the shark. Juveniles and adults are carnivorous, opportunistic, benthic and littoral feeders. Small sharks (<90 cm) in Elkhorn Slough are known to feed almost entirely on crabs and in San Francisco Bay, on crabs and shrimp, particularly of the genus *Crangon*. Leopard sharks 90-120 cm in length feed mostly on echiuroid worms *(Urechis caupo)*. Sharks 120-130 cm feed on crabs, clams, fishes, fish eggs, and *Urechis caupo*. Fishes make up the greatest portion of food eaten by 130-140 cm long sharks. Leopard sharks also prey upon polychaete worms and octopuses and feed rapidly on the eggs of herring, topsmelt, jacksmelt, and midshipmen when available.

Presence of mud-burrowing prey in their diet signifies that the leopard shark is feeding very close to or in the mud. The leopard shark must display a sucking or digging behavior to remove clam siphons and *Urecis caupo* from the mud. In Elkhorn Slough, adult leopard sharks seasonally shift their diet preference. During the fall, when fish eggs are not abundant, they feed more on clams and crabs. During the winter and spring, the yellow shore crab decreases in importance whereas cancrid crabs, fish eggs, and *Urechis caupo* increase as prey items. Leopard sharks do not compete for food sources with neighboring shark species because their diets differ.

Stock Status and Trends The leopard shark probably has no major predators except man and possibly other shark species . Leopard sharks can be caught by set lines, rod and reel, trawls, gill nets, and spear fishing. They are caught and sold commercially year-round and have been targeted by small scale commercial line fisheries in San Francisco Bay. From Eureka southward, the commercial fishery takes leopard sharks with gillnets and longlines, and occasionally with trawls Recreational landings are larger than those of the commercial landings.

B.1.4.2 Soupfin Shark (*Galeorhinus zyopterus*) were subjected to an intensive fishery from California to British Columbia during the 1940s. Taken primarily for their livers which were a source of vitamin A, the fishery declined after 1946 due to reduced demand and abundance. Current demand for soupfin sharks is for food.

Distribution and Life History Soupfin sharks are found from northern British Columbia to Abreojos Point, Baja California and the Gulf of California.

Soupfin sharks are an abundant coastal-pelagic species of temperate continental and insular waters. They are often associated with the bottom, inhabiting bays and muddy shallows. Although the soupfin sharks are often found well offshore, they are not oceanic. Although soupfin shark often occur as shallow as 1 fm (2 m), they also occur in submarine canyons up to 257.5 fm (471 m). The population of soupfin sharks along the western Pacific Coast is considered to be homogeneous.

Males and females apparently segregate by sex. Adult males favor deeper waters, whereas females occur closer inshore. The proportion of males is greater in northern waters off California whereas females occur mostly in southern California waters with a mix of sexes in central California waters. Young soupfin are abundant in southern California waters, probably in association with the larger number of females there.

San Francisco Bay, Tomales Bay, and southern California inshore areas (south of Point Conception) are used as pupping grounds.

Soupfin sharks forms dense shoals and has a coastwide movement that is not completely understood. The soupfin migrates north in summer and southward in the winter. They have extensive movements without recognizable patterns of up to 56 km per day with sustained speeds of 16 km per day for 1600 km.

Mating occurs during the spring and fertilization is internal. Eggs grow to a size of 4-6 cm in diameter before they are hatched within the mother. There is no yolk-sac placenta. After a gestation period of approximately 1 year, females move into bays to bear their live young. Litter sizes range from 6-52 young and average 35. The number of young depends on the size of the mother; larger females produce more young.

Newborn soupfin range in size from 30-40 cm in length. Males mature at 120-170 cm while females mature at 130-185 cm in length. Males can reach a maximum length of 155-175 cm and females can grow to 174-195 cm. Estimated age of maturity and maximum age are reported as 12 and 40 years, respectively.

Soupfin sharks are opportunistic, carnivorous feeders. They feed at the bottom, mid-depths, and at the surface. Diversity of pelagic and bottom-living prey indicates soupfin will pursue food where available. Soupfin feed primarily on moderate-sized bony fishes but also readily feed on invertebrates. Young may consume more invertebrate prey than adults.

Prey items include: herring, sardines and other clupeids, anchovies, salmon, smelt, hake, cod, lingcod, midshipmen, flying fish, mackerel and small tuna, barracuda, croakers, wrasses, opaleye, surfperches, damselfishes, gobies, kelp fish, halibut and other flatfishes, rockfishes and scorpionfish, sculpins, sablefish, cephalopods, marine snails, crab, shrimp, annelid worms, echinoderms, and uncommonly other chondrichthyians such as ratfish, sharks, and small stingrays and skates.

Predators include the spotted sevengill shark, the great white shark, marine mammals, and man.

Stock Status and Trends Of the sharks on the west coast, the soupfin shark has been one of the most economically important. The fishery is generally confined to water within 100 miles of the shore and consists of fishing with bottom and pelagic gillnets, longlines, trawls, and with hook-and-line. Because the soupfin is long-lived and reproduces at a comparatively slow rate, it is especially vulnerable to intensive and prolonged fishing pressures.

B.1.4.3 Spiny Dogfish (*Squalus acanthias*) is a smaller species of shark with a more northerly distribution centering off Washington and British Columbia. Although taken in both sport and commercial fisheries, the spiny dogfish has suffered from a bad reputation as a nuisance fish due to its tendency to create havoc with fishing gear. Spiny dogfish mature at the advanced age of 20 years and only produce a few young, thus are vulnerable to overfishing.

Distribution and Life History Spiny dogfish are found in temperate and subarctic latitudes in both the northern and southern hemispheres. In the northern and central Pacific Ocean, they occur from the Bering Sea to Baja California.

For the North Pacific and Bering Sea, spiny dogfish is an inner shelf-mesobenthal species with a depth range of 0-900m. From survey data, they determined that most dogfish inhabit waters ≤350 m. They occur from the surface and intertidal areas to greater depths, and are common in estuaries, such as San Francisco Bay and Puget Sound, and in shallow bays from Alaska to central California.

Adult females move inshore to shallow waters during the spring to release their young. Small juveniles (<10 years old) are neritic while subadults and adults are mostly sublittoral-bathyal. Subadults are found on muddy bottoms when not found in the water column.

Spiny dogfish may occur in waters as deep as 1000 m, but occur more commonly at depths less than 191.4 fm (350 m). They also inhabit the mesobenthal (outer slope) zone. Known physical and chemical requirements are euhaline waters of 3.7-15.6°C, with a preferred range of 6-11°C.

In southern California, spiny dogfish are often found in close association with white croaker.

Dogfish often migrate in large schools which feed actively on their journeys. Seasonal migrations are taken so as to stay in the preferred temperature range. Schooling behavior occurs with inshore populations and with migratory offshore populations. The schools, numbering in the hundreds, exhibit north-south coastal movements and onshore-offshore movements that are not completely understood. The schools tend to divide up according to size and sex although the young, both male and female, tend to stay together.

Spiny dogfish can travel long distances. In one instance a tagged dogfish from Queen Charlotte Sound in 1980 was recovered off the northeast coast of Japan in 1982. They also make diel migrations from near bottom during the day to near surface at night.

Mating with internal fertilization occurs on the ocean bottom between October and January. Spiny dogfish are ovoviviparous. Fecundity is 1-26 eggs per female, per season. Males mate annually and females mate biannually. Their gestation period lasts 18-24 months (usually 23 months), the longest of any vertebrate. Females release their young during the spring in shallow waters.

Small litters (4-7 pups) are common, but litter size may range from 2-20 pups. Newborn pups range in length from 20 to 23 cm. Females reach sexual maturity at 23-35 years and males reach maturity at 11-19 years. The maximum age of females is about 70 years. Females live longer than males, which only live to a maximum of 36 years.

Spiny dogfish seem to be larger at the northern end of their range. Adults usually range in size from 75-103 cm, although they may reach a maximum size of 130 cm (10 kg). Their growth rate is 1.5-3.5 cm per year.

They are carnivorous and occasionally scavengers. They are an opportunistic feeder, taking whatever is available. They are important predators on many commercial fishes and invertebrates. Their diet consists primarily of fish and crustaceans, especially sandlance, herrings, smelts, cods, capelin, hake, ratfish, shrimps, and crabs. Fish become a more important dietary source as they grow larger. Other food items include worms, krill, squid, octopus, jellyfish, algae, and any carrion. Although most of their diet consists of pelagic prey, they also feed on benthic organisms . They are voracious predators that can be quite aggressive in pursuit of prey.

Based on occurrences, 55% of the diet of dogfish off British Columbia was teleosts, 35% crustaceans, and 5% molluscs. The principal food items consisted of herring and euphausids. Pelagic prey consisted of 80% of their diet and they consumed twice as much food in the summer as in the winter.

Spiny dogfish may compete with sablefish, Pacific cod, soupfin shark, and sea lions. They have few natural predators, except blue and tiger sharks and some marine mammals. For defense, it possesses a strong spine in front of its two dorsal fins that is partially sheathed by toxic tissue.

Stock Status and Trends They are the most abundant and economically important shark off North American coasts. In recent years, large numbers of dogfish have been taken in commercial trawl, set net, and longline fisheries, especially in Puget Sound, to supply foreign markets.

Spiny dogfish can be readily caught by rod and reel, longline, trawl or set net. They are fished for biology class dissections and research. Dogfish are often regarded as a menace to fisheries because they cause damage to nets, lines, and rob hooks.

B.1.4.4 Big Skate (*Raja binoculata*) make a small but significant contribution to regional commercial fisheries. Pectoral fins containing a firm white meat are taken for sale on fresh fish markets. No formal stock assessment has been conducted on skates. Due to their low fecundity, they may be vulnerable to overfishing.

Distribution and Life History Big skates are found from Glubokaya Bay and Cape Narvarin in the western Bering Sea to off Cedros Island, central Baja California, Mexico, but are uncommon south of Point Conception.

Big skates are relatively abundant in northern and central California, but are not common south of Point Conception . The big skate occupies inner and outer shelf areas, particularly on soft bottom.

Records show big skates inhabiting water as shallow as 2 fm (3 m), but in survey catches in the North Pacific they are found most frequently on the outer shelf in waters 27-109 fm (50-200 m deep). Over their range, big skates have been taken from waters up to 437 fm (800 m); however, few occur deeper than 191 fm (350 m).

Egg cases of big skates are deposited on the bottom. Off Oregon, skates were taken at depths up to 60 fm (110 m), but were by far most abundant at 35 fm (64 m).

Little is known about the movements of big skates.

Big skates have a low rate of fecundity. They are oviparous; eggs are fertilized internally and deposited on the bottom to develop and hatch. When the eggs are laid, they are covered with a thick leathery membrane, the egg capsule or shell. The shape of the big skate egg capsule is characterized by two prominent dorsal ridges, the rectangular outline with deep notches in the middle portion and short, flattened horns. The egg case is unique among skates because it can measure up to 30 cm in length and can contain up to 7 eggs per case with an average of 3-4.

Some early researchers believe egg cases are laid year round, whereas others indicate a possible seasonal laying. The egg cases in early development are green-brown in color and those in later stages of development are brownish black. It is also speculated that big skates remain in their egg cases for almost a year.

When the young hatch, they are fully developed, although they do have a yolk sac that is gradually absorbed.

The big skate is a long-lived species that grows and matures slowly. They probably live to be 20-30 years of age. Off central California, some males may mature by age 6, but most are mature by age 10-11. Most females were mature by age 12.

The big skate feeds on crustaceans and fishes.

Stock Status and Trends Coastal trawl fleets account for the majority of the catch off the west coast, although some skates are caught by trammel nets in California and longlines in Puget Sound. Only the pectoral fins, or "wings," are bought commercially. Skates are caught incidentally by fisheries for sole and rockfish. In California, the leading areas for skate landings are San Francisco and Monterey. Big skates are also occasionally taken by recreational fishers, particularly in Monterey Bay.

B.1.4.5 California Skate (*Raja inornata*)

contributes to regional commercial fisheries. Pectoral fins containing a firm white meat are taken for sale on fresh fish markets. No formal stock assessment has been conducted on skates. Due to their low fecundity, they may be vulnerable to overfishing.

Distribution and Life History California skates range from the Strait of Juan de Fuca, Canada south to Cedros Island, central Baja California, Mexico.

The California skate is common off most of the California coast, as well as inshore and in shallow bays (10 fm (18 m) of water or less). The California skate has been taken as deep as 367 fm (671 m). California skates typically inhabit inshore muddy bottoms. Egg cases are deposited on the bottom.

Little is known about the movements of skates.

California skates, like other skates, are oviparous, have internal fertilization, and deposit their eggs on the bottom to develop and hatch. When the eggs are laid, they are done so in a distinctive leathery case. The egg case of California skates is smooth with horns. When the eggs hatch, the young are fully developed although they do have a yolk sac that is gradually absorbed.

Skates are long-lived creatures that grow and mature slowly. Their lifespan is estimated at 20-30 years. Females and males reach sexual maturity at approximately 52 cm in length and attain a maximum TL of 76 cm.

The California skate feeds on shrimps and probably other invertebrates.

Stock Status and Trends Coastal trawl fleets account for the majority of the commercial catch off the west coast, although some are caught by trammel nets in California and longlines in Puget Sound. Only the pectoral fins, or "wings," are bought commercially. Skates are caught incidentally in fisheries for sole and rockfish. In California, the leading areas for skate landings are San Francisco and Montere.

B.1.4.6 Longnose Skate (*Raja rhina*) contributes to regional commercial fisheries. Pectoral fins are taken for sale on fresh fish markets but the meat is not as desirable as wing meat of other species. No formal stock assessment has been conducted on skates. Due to their low fecundity, they may be vulnerable to overfishing.

Distribution and Life History Longnose skates are found from Navarin Canyon in the Bering Sea and Unalaska Island in the Aleutian Islands to Cedros Island, Baja California, Mexico.

The longnose skate is one of the more common skates and occurs on the bottom in inner and outer shelf areas from 30-340 fm (55-622 m). Based on survey data for the North Pacific, they are most frequently taken at depths of 100-150 m, with nearly all taken at depths ≤191 fm (350 m). Eggs are deposited on the bottom.

Little is known about their movements.

Longnose skates, like other skates, are oviparous, have internal fertilization, and deposit their eggs on the bottom to develop and hatch. When the eggs are laid, they are enclosed in a rough, leathery shell with a loose covering of fibers and short horns. Their egg cases generally hold one egg each and are 8-12 cm in length. When the eggs hatch, the young are fully developed although they do have a yolk sac that is gradually absorbed .

Skates are long-lived creatures that grow and mature slowly. Their lifespan is estimated at 20-30 years. Male longnose skates are smaller than females. Off central California, males begin maturing at age 5-6, and females at age 8. Males are mature by age 10-12 years.

Stock Status and Trends Coastal trawl fleets account for the majority of the commercial catch off the west coast, although some are caught by trammel nets in California and longlines in Puget Sound. Only the pectoral fins, or "wings," are bought commercially. Skates are caught incidentally by fisheries for sole and rockfish. In California, the leading areas for skate landings are San Francisco and Monterey.

B.1.4.7 Ratfish (*Hydrolagus colliei*) are not sought after by either sport or commercial fishers. This interesting species occupies shallow waters of the continental shelf, but can be found as deep as 500 fm (2,995 ft).

Distribution and Life History Ratfish are found from Cape Spencer in southeast Alaska to Sebastian Vizcaino Bay, Baja California, and in the northern part of the Gulf of California.

In the North Pacific, ratfish are considered a middle-shelf-mesobenthal species and have been reported at depths of 0-499 fm (0-913 m). In survey data, they most frequently occur between 100-150 m, with nearly all taken at depths of 27-219 fm (50-400 m).

Ratfish are a common demersal fish in larger estuaries throughout its range, especially from early winter to late spring. It is believed that ratfish enter estuaries to feed and mate; they do not occur as often in estuaries in summer and fall. In Puget Sound, ratfish often occur in less than 5 fm (10 m) of water, depending on the time of day and season.

All free-swimming life history stages share essentially the same habitat; there is no partitioning by age or size.

Generally, ratfish is a deepwater species that prefers low relief rocky bottoms. Ratfish also prefer exposed gravel and cobble as a habitat and are not common on sand or over boulders.

Eggs are attached by the mother to rocks, or placed upright in the sand in polyhaline to euhaline waters. In the summer and fall, ratfish move offshore into deep waters. It is in these deep waters that egg cases are most often deposited.

Although they are poorly understood, it is known that ratfish make significant seasonal and diel migrations. In the winter, ratfish move into shallow nearshore waters and estuaries, probably for feeding and pre-spawn mate selection. In Puget Sound and other estuaries, ratfish move from deep water by day to much shallower water at night. This diel migration is undertaken mostly by smaller fish, suggesting it is preferred feeding ground for young ratfish, or a means of predator avoidance. Migrations may be completed to regulate ambient light conditions for ratfish because they have an all-rod retina and no means of regulating the amount of light entering their eyes.

Ratfish are oviparous and fertilization is internal. Spawning occurs at all times throughout the year, but seems to peak from late summer to early fall. Ratfish, regardless of size or age, produce only two egg cases per year.

Fertilized egg capsules are elongate, diamond-shaped, and are about 125 mm long at extrusion. The egg case hangs by capsular filaments from the mother's oviducts for 4-6 days before being deposited on rocks or placed in sand where it completes development and hatches. Full development of the egg may take up to a year. Larval stages are completed in the egg, and the hatched ratfish resembles a small adult.

Females grow faster and reach a larger mean size than do males. Female ratfish may reach 97 cm in length.

Ratfish at all life history stages are opportunistic feeders; no one single food item usually makes up more than 25% of a ratfish's diet. Common foods are isopondylous fishes, mollusks, squid, nudibranchs, opisthobranchs, annelids, and small crustaceans. On more than one occasion, a ratfish was found with a stomach full of seaweed. Off southern California, the most important prey were brittle stars, ostracods and amphipods.

Ratfish seek their food by smell and weak electroreception in the pits on their heads.

Ratfish are in turn preyed upon by Pacific halibut, soupfin shark, and spiny dogfish. Ratfish have been recorded as being cannibalistic.

Stock Status and Trends There is no directed fishery for ratfish in the northeast Pacific, but they are taken quite often as bycatch in bottom trawls. Ratfish are not sought by recreational fishers, but are caught occasionally while fishing for other demersal species.

B.1.4.8 Finescale Codling (*Antimora microlepis*) are a deep-water species, sometimes taken as bycatch in the longline fishery for sablefish.

Distribution and Life History Finescale codling, also known as Pacific flatnose, occur from Shikoku Island, Japan, through the southeastern Bering Sea, to the Gulf of California.

Finescale codling are mesobenthal-bathybenthal, with a reported depth range of 96-1,667 fm(175-3,048 m). In survey data for the North Pacific, they were taken at depths up to 697 fm (1,275 m), most often on the bathybenthal slope between 437-465 fm (800-850 m). Nearly all survey catches were at depths >191 fm (350 m).

There is no biological information available on the biology and life history characteristics of finescale codling.

Status of Stock There is no directed fishery for finescale codling. Finescale codling are taken as incidental catch in the longline fishery for sablefish.

B.1.4.9 Pacific Rattail *(Coryphaenoides acrolepis)* support a growing deepwater commercial trawl fishery. There has been no formal stock assessment on the species.

Distribution and Life History Pacific rattails (also known as Pacific grenadiers) are found in the northeast Pacific from the Bering Sea off Alaska to Baja California.

Stock Status and Trends A commercial fishery is developing for rattails and they are marketed primarily as grenadiers. Most catches are made with trawl gear, but hook and line (longline) is also effective. Incidental catches of rattails in deepwater trawl fisheries are often used in livestock feeds.

Rattails are among the most abundant fishes of the continental slope and abyssal waters worldwide. They are found at depths from 155 to 2,470 m, most commonly below 820 fm (1,500 m) in the Northeast Pacific Ocean.

Spawning depth is not known. Larval stages of the Pacific rattail have been captured in the water column in waters less than 109 fm (200 m) whereas older larvae and juveniles occur deeper. Newly metamorphosed fish off Oregon settle out of the water column in 273 fm (500 m) or less. As they grow, juveniles move to deeper water.

Pacific rattails occur in highest densities on the sandy bottoms of the abyssal plains of the northeast Pacific, but specific habitat associations for any life history stage have not been studied.

Migrations have not been documented and it is assumed that this is a relatively sedentary species. Larger fish are found in deeper water, suggesting a movement to deep water with increasing size.

Pacific rattails are oviparous and fertilization is external. Ripe females were collected in September, October, and April, possibly indicating two spawning seasons per year. Off southern California, spawning occurs mostly from late winter to early spring, although spent females are found throughout the year. Fecundity has been estimated to be between 22,657 and 118,612 eggs per female and as much as 150,000 eggs in a large female off California.

Fertilized eggs are about 2.0 mm in diameter. Larvae hatch at about 2 mm total length and are pelagic, occurring in the upper 109 fm (200 m) of the water column. Metamorphosis occurs at about 10 mm total length.

Female rattails mature at about 650 mm total length; males mature as small as 480 mm total length. Female rattails grow faster and reach a larger average size than do male rattails. Maturity is reached in about 10 years or more, based on estimated size at maturity.

Stomach contents of rattail fishes are usually evacuated between capture and retrieval of the fish, so analysis of stomach contents is difficult. Stomachs have been observed to contain the remnants of cephalopods, other demersal fishes (often other macrourids) and sinking food particles of dead nekton. The food and feeding of larvae and juveniles is not known.

Rattails are, in turn, likely preyed upon by other demersal fishes, including other macrourids. Cannibalism is not uncommon, and may be responsible for high larval and juvenile mortality.

B.2 Other Relevant Fish Stocks (Finfish, Shellfish and Squid)

Relevant fish stocks included in this section are those known to be or likely to be substantively affected by or affect groundfish fisheries, groundfish species or their habitats. Impacts may potentially occur between groundfish species or fisheries and other fish, shellfish, and invertebrates not included in this section, but little is known about them. Some species, such as invertebrates in the deep oxygen minimum zone off the west coast, may be especially vulnerable to fishing impacts, but again, little is known about them.

B.2.1 Pacific Salmon

The distribution and life history of two of the five Pacific salmon species, chinook and coho, are described primarily for the juvenile and adult stages of their life that are spent in the marine environment. Biological information comes primarily from PFMC(1999a).

The generalized life history of salmon includes incubation and hatching of embryos, emergence and initial rearing of juveniles in freshwater; migration to oceanic habitats for extended periods of feeding and growth; and return to natal freshwaters for completion of maturation, spawning, and death.

B.2.1.1 Chinook Salmon (*Oncorhynchus tshawytscha*), also called king salmon, range widely throughout the north Pacific Ocean and the Bering Sea, and as far south as the U.S./Mexico border.

Chinook salmon typically remain at sea for one to six years.

Distribution and Life History After leaving the freshwater and estuarine environment, juvenile chinook disperse to marine feeding areas. Some tend to be coastal-oriented, preferring protected waters and waters along the continental shelf. In contrast, others pass quickly through estuaries, are highly migratory, and may migrate great distances into the open ocean.

Along the U.S. west coast, juvenile chinook salmon most commonly occur less than 28 km offshore.

Chinook salmon typically remain at sea for one to six years. They have been found in ocean waters**.** They are most abundant at depths of 30-70m and often associated with bottom topography. However, during their first several months at sea, juveniles are predominantly found at depths less than 37 m and are distributed in the water column.

Juvenile chinook are generally found within 55 km of the U.S. west coast, with the vast majority of fish found less than 28 km offshore. Concentrations may be found in areas of intense upwelling. The historic southern edge of their marine distribution appears to be near Point Conception, California.

Throughout their range, adult chinook salmon enter freshwater during almost any month of the year. For example, chinook enter the Columbia River between March and November and the Sacramento River between December and July.

Chinook salmon mature at a wide range of ages, from two to eight years. Most adult females are 65-85 cm in length and males are 50-85 cm, although fish larger than 100cm are not uncommon.

Chinook salmon are the most piscivorous of the Pacific salmon. Fish make up the largest part of their diet, but squids, pelagic amphipods, copepods, and euphausiids are also important.

Many populations of chinook salmon on the U.S. west coast are at very low abundance and several have been listed as "threatened" under the ESA.

Stock Status and Trends Declines in the abundance of chinook salmon have been well documented throughout the southern portion of their range. For example, the Columbia River formerly supported the world's largest chinook salmon run, but currently five ESUs (evolutionarily significant units) in the Columbia Basin are listed as "threatened" under the ESA.

B.2.1.2 Coho Salmon (*Oncorhynchus kisutch*),

also called silver salmon, are a commercially and recreationally important species. They are found in small rivers and streams throughout much of the Pacific Rim, from central California to Korea and northern Hokkaido, Japan.

Juvenile coho spend about 18 months at sea before returning to spawn in natal streams.

Distribution and Life History Coho salmon spawn in freshwater streams, juveniles rear for at least one year in fresh water and spend about 18 months at sea before reaching maturity as adults. North American populations are widely distributed along the Pacific coast and spawn in tributaries to most major river basins from the San Lorenzo River in Monterey Bay, California, to Point Hope, Alaska.

Two primary dispersal patterns have been observed in coho salmon after emigrating from freshwater. Some juveniles spend several weeks in coastal waters before migrating northwards into offshore waters of the Pacific Ocean while others remain in coastal water near their natal stream for at least the first summer before migrating north. The latter dispersal pattern is commonly seen in coho salmon from California, Oregon, and Washington.

Coho salmon rarely use areas where sea surface temperature exceeds 15 °C and are generally found within the uppermost 10 m of the water column. While juvenile and maturing coho are found in the open north Pacific, the highest concentrations appear to be found in more productive waters of the continental shelf within 60 km of the coast. Adults enter fresh water during October and November in Washington and Oregon and during December and January in California.

> Coho salmon are generally found within the uppermost 10 m of the water column and within 60 km of shore.

Marine invertebrates, such as copepods, euphausiids, amphipods, and crab larvae, are the primary food when coho first enter salt water. Fish represent an increasing proportion of the diet as coho grow and mature.

Stock Status and Trends Many coho salmon populations in Washington, Oregon, and California are depressed from historical levels with stocks at the southern-most end of the range generally at greatest risk of extinction. Coastal stocks from the Columbia River to the southern extent of their range in Monterey Bay were listed as “threatened” under the ESA, and stocks from the Columbia River Basin, southwest Washington, and Puget Sound are candidates for listing.

> The abundance of many coho populations is very low, and several are listed as “threatened” under the ESA.

B.2.2 Pacific Halibut (*Hippoglossus stenolepis*)

ranges from California to the Bering Sea and extends into waters off Russia and Japan. The International Pacific Halibut Commission (IPHC) is responsible for the research and assessment of Pacific halibut in the Northeast Pacific ocean.

Distribution and Life History Pacific halibut is a large flatfish which inhabits the continental shelf of the United States and Canada (IPHC 1998). Pacific halibut are demersal and are most often caught between 90 and 900 feet (27 and 274 meters). Halibut from California through the Bering Sea are considered to form one homogeneous population (Trumble 1991). Halibut off the west coast are at the extreme southern end of their range; the majority of the stock and all major spawning grounds are in

> Halibut off the west coast are a small part of the halibut population off North America.

more northern waters off Canada and Alaska. The halibut that inhabit west coast waters result from the southerly migration of juveniles.

> Migration of juveniles southward from waters off Alaska and British Columbia replenishes the stock off the west coast.

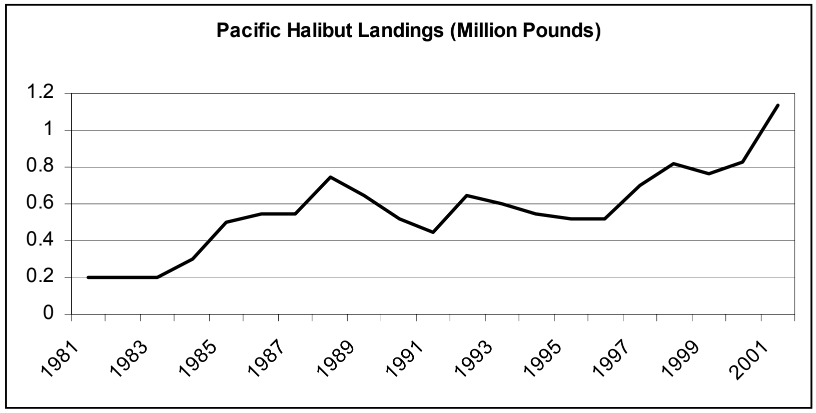
Halibut spawn during the winter in deep water (approximately 1,000 feet or 300 m). Their eggs and larvae rise and drift great distances with the ocean currents in a counter-clockwise direction around the northeast Pacific Ocean. Young fish settle to the bottom in shallow feeding areas. After two or three years in the nursery areas, young halibut tend to counter-migrate and move into more southerly and easterly waters. Juvenile migration is usually completed by the age of six. Adult fish tend to remain on the same grounds year after year, making only a seasonal migration from the more shallow feeding grounds in summer to deeper spawning grounds in the winter (IPHC 1998).

> Halibut are large, fast-growing and long-lived.

Pacific halibut are the largest of all flatfish (up to about 500 pounds or 227 kg). Females typically grow faster and live longer than males; nearly all halibut over 100 pounds (45 kg) are females. The oldest halibut on record was 55 years old, but most are less than 25 years old. The growth of Pacific halibut has varied over the years and for the past decade, weight at a given age has been decreasing. The mean age in the commercial halibut catch off the west coast ranged from 9.8 to 11.4 years during 1988-1996 (IPHC 1998).

> Pacific halibut prey upon a variety of groundfish, shellfish, and baitfish.

Halibut are carnivorous. Larval halibut feed on plankton. Halibut one to three years old feed on small crustaceans and small fish. As halibut grow, fish become a larger part of their diet. They prey upon cod, sablefish, pollock, rockfishes, sculpins, turbot, and other flatfish. They also leave the bottom to feed on sand lance and herring in the water column. Octopus, crabs, clams, and occasionally small halibut are also eaten. Large juvenile and adult halibut are occasionally eaten by marine mammals but are rarely prey for other fish.



Stock Status and Trends IPHC conducts the stock assessment of halibut throughout its north American range. Methods for assessing the status of halibut off the west coast are provided in Clark (1991a) and Clark and Williams (2001). For assessment purposes, Pacific halibut off the west coast (IPHC Area 2A) and off British Columbia (IPHC Area 2B) have been combined since the early 1980s (Clark and Hare 2001; Clark and Williams 2001). Data from the west coast are weak because only small quantities of fish are involved and only a small number of observations are available. Until 2001, the stock size (exploitable biomass) of halibut off the west coast was estimated as a proportion of the total for the two areas. As a result of a reanalysis and reevaluation of assessment methods for these areas in 2001, the biomass off the west coast was estimated from survey data and a separate assessment of abundance in British Columbia. This change resulted in about a 5% increase in the biomass estimate for west coast halibut (Clark and Hare 2001).

Although assessment methods have varied, catch limits generally reflect trends in estimated abundance. Catch limits have typically been based on a constant exploitation yield, calculated by applying a fixed harvest rate to estimated biomass. West coast catch limits set by IPHC for the combined commercial setline, tribal, and sport fisheries have increased significantly since the late 1990s.

B.2.3 California Halibut (*Paralichthys californicus*) range from the Quillayute River, Washington to Almejas, Baja California, but their abundance and commercial fishery in U.S. waters are concentrated from Bodega Bay to San Diego, California.

Although they range from Washington to Baja California, California halibut are most abundant off central and southern California.

Information on life history and stock status is from Kramer, et al, (2001), Wang(1986), and Kucas and Hassler (1986). California Dept. of Fish and Game (CDFG) manages fisheries for California halibut off its coast; little fishing and catch occurs off Oregon and Washington.

Distribution and Life History Adults live on soft bottom habitats in coastal water generally less than 300 feet (91 m) deep, with greatest abundance at depths less than 100 feet (30 m).

California halibut live up to 30 years and reach 60 inches (153 cm). Male halibut mature at one to three years of age and eight to twelve inches (20 - 30 cm), whereas females mature at four to five years and 15 to 17 inches (38 - 43 cm).

Adults may live more than 30 years, reach 60 inches, and are usually found on soft bottoms less than 100 feet deep.

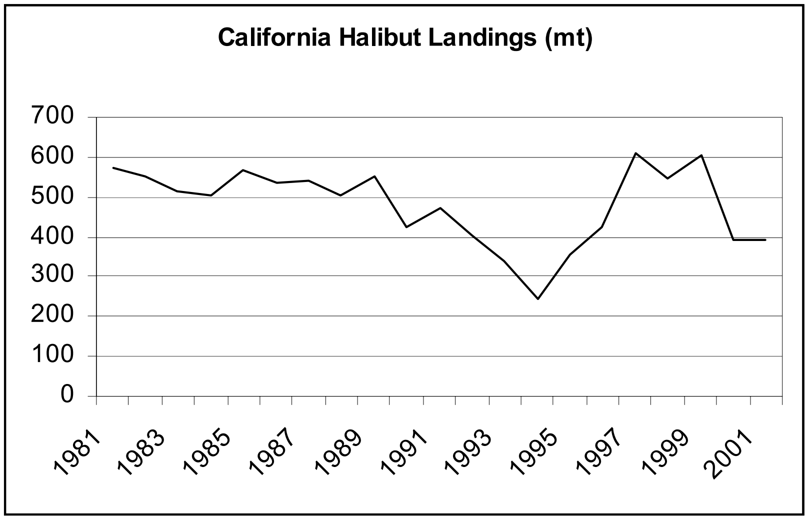
Adults spawn throughout the year with peak spawning in winter and spring. Pelagic eggs and larvae drift over the shelf but are in greatest densities within four miles of shore. Larvae apparently move toward shore as they metamorphose into a bottom-dwelling life.

Newly settled and larger juvenile halibut are usually found in unvegetated shallow-water embayments, and infrequently on the open coast, suggesting that embayments are important nursery habitats. Juveniles emigrate from the bays to the coast at about one year of age and 6.9 to 8.7 inches (17.5 - 22 cm).

Tagging studies show that California halibut do not move long distances. Most sublegal (under 22 inches or 56 cm) halibut were recovered within five miles from their tag sites in southern California. Larger halibut tend to travel the greatest distances; one large halibut was recovered 64 miles (103 km) away 39 days after release.

Current abundance of California halibut is not known, but in the early 1990s, an estimated 4.6 million fish inhabited southern and central California waters.

Adult California halibut primarily prey upon Pacific sardine, northern anchovies, squid, and white croaker. Small juvenile halibut eat primarily crustaceans, including copepods and amphipods until they reach about 2.5 inches (6.4 cm). As they grow, juvenile halibut increasingly prey upon fish, beginning with gobies, which are common in bays.



Stock Status and Trends Estimates of the current abundance of California halibut are not available. In the early 1990s, a fishery-independent trawl survey produced a biomass and population estimate for halibut in southern and central California. That survey indicated a biomass of 6.9 million pounds (3,129 mt) for southern California and 2.3 million pounds (1,043 mt) for central California. Population numbers were estimated to be 3.9 million halibut in southern California and 700,000 halibut for central California. Coastwide commercial landings have generally been between 400 and 600 mt per year during the 1980s and 1990s.

Abundance of larval halibut in plankton surveys is correlated with commercial landings of halibut, suggesting that this species has a cycle of abundance of about 20 years. However, the maximum size of the halibut population may be limited by the amount of available nursery habitat, because juvenile halibut appear to be dependent on shallow-water embayments as nursery areas.

Ocean shrimp occur over the continental shelf from the Aleutian Islands to southern California.

B.2.4 Ocean Shrimp (*Pandalus jordani*), also called pink shrimp, occur from the Aleutian Islands to San Diego, California. State agencies plus the Washington treaty tribes manage the ocean shrimp resource and fisheries off their respective coasts.

Ocean shrimp concentrate in well-defined areas, often associated with green mud and muddy-sand bottoms.

Environmental conditions determine ocean shrimp recruitment success and population size.

Distribution and Life History Ocean shrimp occur at depths from 150 to 1,200 feet (46 - 366 m) but are generally found at depths from 240 to 750 feet (73 - 229 m). Concentrations of shrimp remain in well-defined areas or beds from year to year. These areas are associated with green mud and muddy-sand bottoms. Adults from different beds probably intermix rarely, but the planktonic larvae undoubtedly intermingle. Genetic studies for stock identification have not shown any genetic differences between ocean shrimp off the coasts of California, Oregon, Washington, and British Columbia (Collier and Hannah 2001).

Most ocean shrimp spend the first year and a half of life as males, then pass through a transitional phase to become females. In some years, as much as 60% of the one-year-old shrimp become females and never mate as males (Collier and Hannah 2001). Ocean shrimp adjust their sex ratio to fluctuating age distributions (Charnov and Hannah 2002).

> Most ocean shrimp begin life as males and change to females after their first year.

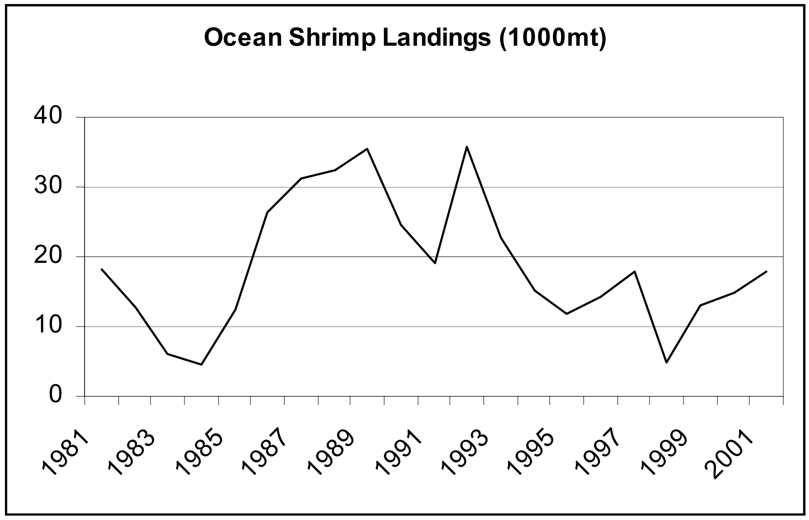
Mating takes place during September and October. Fertilization takes place when the females begin extruding eggs in October. Females usually carry between 1,000 and 2,000 eggs until the larvae hatch in March and April. The larval period lasts 2.5 to three months. Developing juvenile shrimp occupy successively deeper depths, and often begin to show in commercial catches by late summer.

Ocean shrimp grow in steps by molting or shedding their shells and growth rates vary by region, season, sex and year class. They may reach 5.5 inches (14 cm) in total length, but the average size in the catch is about four inches. Ocean shrimp grow rapidly during spring and summer but have slower growth during the winter.

> Many groundfish species prey upon ocean shrimp, and predation by Pacific whiting may affect the abundance of ocean shrimp.

Ocean shrimp feed mainly at night on planktonic animals, such as euphausiids and copepods. Likely in association with feeding, they migrate toward the surface during periods of darkness.

Many species of fish prey on ocean shrimp, including Pacific whiting, arrowtooth flounder, sablefish, petrale sole and several species of rockfish (Collier and Hannah 2001). Predation by whiting may affect the abundance of ocean shrimp. An analysis of data on ocean shrimp from commercial catches and logbooks during the 1980s and data on whiting abundance showed that natural mortality rates were positively correlated with the abundance of Pacific whiting, age 2-7 (Hannah 1995).



Stock Status and Trends Estimates of ocean shrimp abundance are not available for the west coast. Population abundance is determined by environmental conditions, which cause natural fluctuations in recruitment that bear little relation to fishing effort (Collier and Hannah 2001). Off Oregon, annual recruitment success is linked to the strength and timing of the spring transition in coastal currents immediately following larval release. An early, strong transition produces large year classes. Consequently, ocean shrimp may be inherently resistant to overfishing (Collier and Hannah 2001). Abundance of ocean shrimp off the Washington coast is unknown, but is assumed to be stable (WDFW 2002).

Ocean shrimp catches (PacFIN annual reports, PSFMC) by commercial trawl and pot fisheries may indicate past trends in abundance. Since 1982, commercial landings have ranged from 4,500 to 36,000 mt, and were about 18,000 mt in 2001.

B.2.5 Prawns

Although several species of prawns occur along the west coast, two species have substantive interactions with groundfish. These species are spot and ridgeback prawns. Prawns are managed by the respective west coast states and Washington treaty tribes. Information on the biology and status of spot prawns is drawn primarily from Mormorunni (2001) with additional information as cited below. Information on the biology and status of ridgeback prawns is from Sunada, *et al*.(2001).

Annual commercial landings of spot and ridgeback prawns off the west coast during 1981-2001 are taken from annual PacFIN reports (PSMFC).

Spot prawns range from the Aleutian Islands to San Diego, California, and to the Sea of Japan and Korea Strait.

B.2.5.1 Spot Prawn (*Pandalus platyceros*)

ranges from the Aleutian Islands to San Diego, California, and extends to the Sea of Japan and the Korea Strait.

Distribution and Life History Spot prawns commonly occur at depths from the intertidal zone to 1,600 feet (487 m) and are typically found at depths between 653 and 772 feet (198-234 m). Juvenile shrimp concentrate in shallower, inshore areas (<297 feet or 90m) and migrate offshore as they mature.

Spot prawns occur on rocky or hard bottoms, such as reefs and canyon edges.

Spot prawn distribution is very patchy and related to water temperature, salinity and physical habitat. Spot prawns typically inhabit rocky or hard bottoms, including reefs, coral or glass-sponge beds, and the edges of marine canyons. Research conducted in Monterey Bay, California, showed that spot prawns appeared to actively select habitat. They were more commonly associated with complex habitats of mixed sediment and smaller rock types such as gravel and cobble.

The spot prawn is the largest of the pandalid shrimp, measuring about 2.5 inches (61 mm) in carapace length. They can live up to six years off California but longevity decreases in more northerly areas; the average age off Canada is only four years.

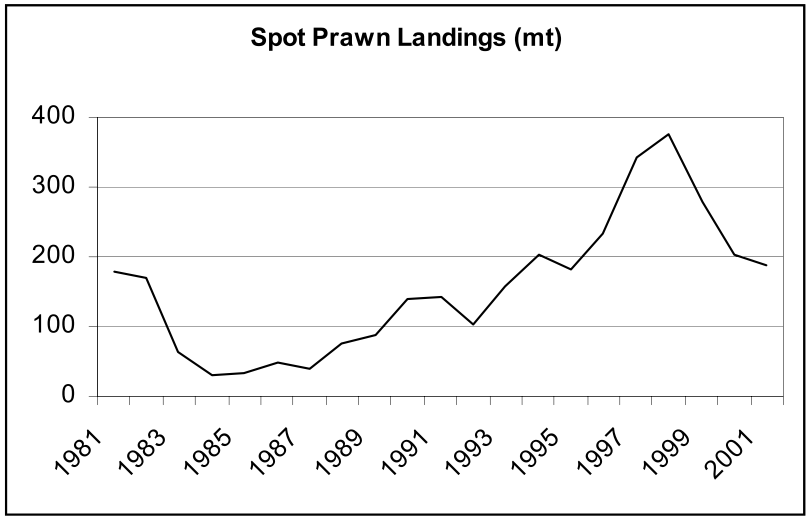
Spot prawns begin life as males and change to females during their fourth year.

Spot prawns change sex in midlife. They mature first as males, mate, and then change to females after a transition phase. Sexual maturity is reached during the third year (about 1.5 inches or 38 mm carapace length). By the fourth year (about 1.75 inches or 44 mm carapace length), many males begin to change sex to the transitional stage. By the end of the fourth year, the transitionals become females. Each individual mates once as a male and once or twice as a female.

Spawning occurs once each year, typically in late summer or early autumn. Spawning takes place at depths of 500 to 700 feet (151-212 m). Females carry eggs for a period of four to five months before they hatch. Depending on size of the female, spot prawns produce from 1,400 to 5,000 eggs for the first spawning down to 1,000 eggs for the second spawning. Eggs hatch over a 10-day period , and most hatching is completed by April. The larvae are free-swimming in the water column for up to three months. As they develop into juveniles, they begin to settle out at shallow depths.

Very little is known about the stock status of spot prawns off the west coast.

Spot prawns typically feed on other shrimp, plankton, small mollusks, worms, sponges and fish carcasses. They usually forage on the bottom throughout the day and night (Larson 2001).



Stock Status and Trends There is little information on spot prawn abundance or relationships among stocks (Lowry 2001; McCrae 1994a; Mormorunni 2001). Landing statistics and fishers' local knowledge are the primary source of information about the status of spot prawns. Commercial landings of spot prawns on the west coast rose during the late 1980s through the late 1990s but have declined since 1999.

B.2.5.2 Ridgeback Prawn (*Sicyonia ingentis*)

occurs from Monterey, California, to Cedros Island, Baja California.

> Ridgeback prawns occur only from Monterey, CA south to Baja California.

Distribution and Life History They inhabit depths ranging from less than 145 feet to 525 feet (44 - 160 m). Major concentrations occur in the Ventura-Santa Barbara Channel area, Santa Monica Bay, and off Oceanside. Other pockets of abundance occur off Baja California.

> Unlike spot prawns, ridgeback prawns do not change sex and females do not carry eggs till hatching.

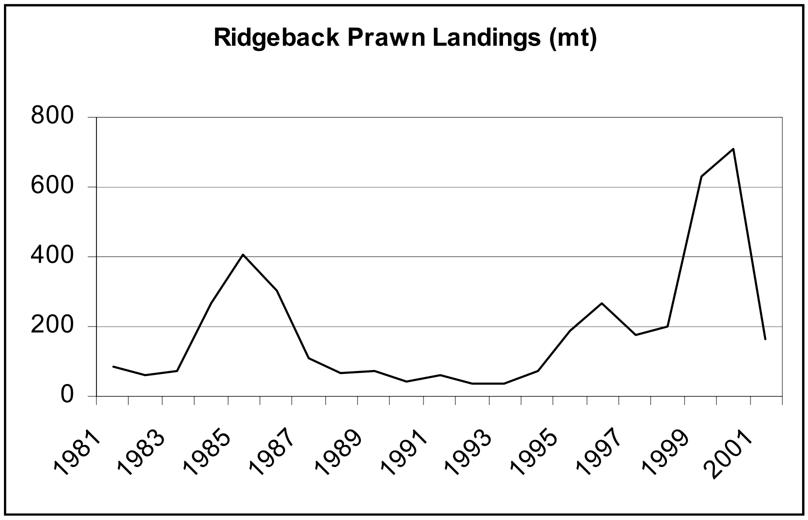
Ridgeback prawns inhabit substrates of sand, shell and green mud. Because they are relatively sessile, little or no intermixing occurs.

Their maximum life span is five years and sexes are separate. Females reach a maximum carapace length of 1.8 inches (46 mm) and males 1.5 inches (38 mm).

> The abundance of ridgeback prawns is not known, although fishery data suggest that abundance may have increased steadily during the 1990s.

Ridgeback prawns are free spawners; as opposed to other shrimps which carry eggs. Both sexes spawn as early as the first year, but most spawn during the second year at a size of 1.2 inches (30 mm). Studies suggest that this species undergoes multiple spawning from June through October. On average, females produce 86,000 eggs. Following spawning, both sexes undergo molting and continue molting throughout winter and spring.

The food habits of the ridgeback prawn are unknown, but it may feed on detritus like closely related species. Likely predators include rockfish, lingcod, octopus, sharks, halibut, and bat rays.



Stock Status and Trends No population estimates are available for any of the major fishing grounds. However, fishery data suggest that their abundance increased substantially during the 1990s. Ridgeback prawn trawl logs, mandatory since 1986, show that catch rates rose steadily from a low of 32 pounds (14.5 kg) per tow/hour in 1992 to 213 pounds (96.6 kg) per tow/hour in 1999. This increase is in addition to increased fishing effort during this period. Commercial landings on the west coast rose from 75 mt in 1994 to 711 mt in 2000, but fell sharply to 165 mt in 2001.

Dungeness crab live in coastal and estuarine areas from Alaska to Mexico, usually over sandy or muddy bottoms.

B.2.6 Dungeness Crab (*Cancer magister*) occur in coastal waters along North America from Unalaska Island to Magdalena Bay, Mexico (ADFG 1994). State agencies and Washington treaty tribes manage the Dungeness crab resource and fisheries off their respective coasts. Information on the distribution and life history is taken from several sources (Pauley *et al.* 1986; Pauley 1989; ADFG 1994) and information on stock status and trends is from WDFW (2001).

Distribution and Life History Dungeness crabs are widely distributed subtidally and prefer a sandy or muddy bottom in salt water. However, they are tolerant of salinity changes and can be found in estuarine environments. Subadults and adults are common offshore. They generally inhabit waters shallower than 90 feet (27.4 m), but they have been found as deep as 600 feet (183 m).

> Crabs grow each time they shed their old carapace (molt) and males can only mate with females that have just molted.

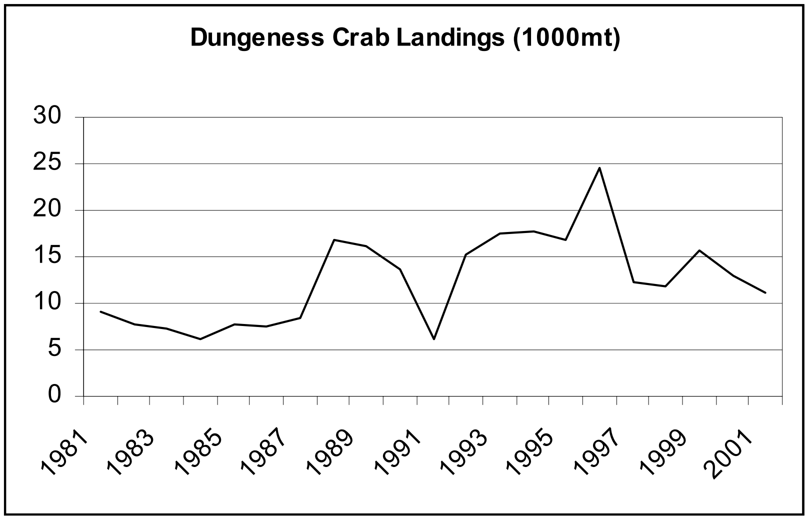
Crabs grow each time they molt (shed their old carapace). After two years, Dungeness males grow faster than females. Juveniles molt 11 or 12 times prior to sexual maturity, which may be reached at three years. At four to five years, a Dungeness crab can be over 6.5 inches (16.5 cm) in carapace width and weigh between 2 and 3 pounds (0.9 - 1.4 kg). A large male can exceed 10 inches (25.4 cm) in carapace width. The estimated maximum life span is between 8 and 13 years.

Dungeness crabs mate from spring through the fall. Males mate only with female crabs that have just molted. A large female crab can carry 2.5 million eggs under her abdomen until hatching. After hatching, the young crabs swim freely. Young planktonic crabs go through six developmental stages before they molt into their first juvenile stage. After molting, the juveniles inhabit shallow coastal waters and estuaries with large numbers living among eelgrass or other habitats with aquatic vegetation. Shell hash, a large deposit of dead clam shells, is also important habitat for young Dungeness crabs.

> Although estimates of abundance are not available, the coastal Dungeness crab resource is considered to be healthy.

Dungeness crabs scavenge along the sea floor for animals that live partly or completely buried in the sand. They are carnivores and their diet includes shrimp, mussels, small crabs, clams, and worms. Cannibalism is common.

Young planktonic crabs are important prey for salmon and other fishes. Juveniles are eaten by a variety of fishes in the nearshore area, especially starry flounder, English sole, rock sole, lingcod, cabezon, skates and wolf eels. Octopus may also be an important predator.



Stock Status and Trends "The coastal Dungeness crab resource is healthy despite large fluctuations in harvest from season to season." Variation in oceanographic conditions will likely continue to cause seasonal abundance to fluctuate as it has in the past, but barring the onset or persistent adverse environmental conditions, the resource is expected to remain healthy (WDFW 2001).

Annual commercial landings of Dungeness crab on the west coast have fluctuated between 6,900 and 26,800 mt since 1981. Data on annual commercial landings of Dungeness crab off the west coast (excluding Puget Sound, Washington) were provided by PSFMC (Daspit 2002).

B.2.7 Market Squid (*Loligo opalescens*)

occur throughout the California and Alaska current systems from the southern tip of Baja California, Mexico, to southeastern Alaska.

The Pacific Fishery Management Council (PFMC) manages market squid off the west coast. Information on the biology and status of market squid is from PFMC's coastal pelagic species fishery management (PFMC 1998b)and from CDFG (2002).

> Market squid occur from southeastern Alaska through Baja California, although they are most abundant south of Monterey Bay, California.

Distribution and Life History Market squid are most abundant from Punta Eugenio, Baja California and Monterey Bay, California. Although generally considered pelagic, they are found over the continental shelf from the surface to depths of at least 2,625 feet (800 m). Adults and juveniles are most abundant between temperatures of 10 °C and 16° C. They prefer oceanic salinities and are rarely found in bays, estuaries, or near river mouths.

Most market squid mature and spawn when about one year old, then die.

Market squid are small, short-lived molluscs reaching a maximum size of 12 inches (30 cm) total length, including arms. Some individuals may live up to two years, but most mature and spawn when about one year old, then die.

Spawning occurs year-round.

Spawning along the west coast occurs year-round. Peak spawning usually begins in southern California during the fall-spring. Off central California, spawning normally begins in the spring-fall. Squid spawning off Oregon has been observed during May to July. Off Washington and Canada, spawning normally begins in late summer.

Spawning squid concentrate in dense schools near spawning grounds, but habitat requirements for spawning are not well understood. Known major spawning areas are shallow semi-protected nearshore areas with sandy or mud bottoms adjacent to submarine canyons. In these locations, egg deposition occurs between 1.5 and 17 feet (5-55 m).

Each female produces egg capsules and deposits them on sandy or mud bottoms.

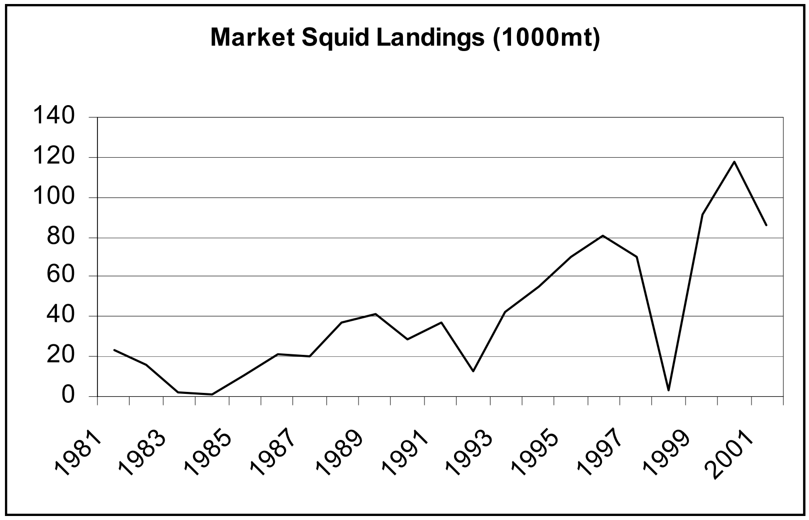
Males on spawning grounds are larger than females. Males reach 7.5 inches (19 cm) dorsal mantle length and a maximum weight of 130 g (4.6 oz). Females reach 6.7 inches (17 cm) dorsal mantle length and a maximum weight of 90 g (3 oz). Mating has been observed on spawning grounds just prior to spawning, but may also occur before squid move to the spawning grounds. Males deposit spermatophores into the mantle cavity of females and eggs are fertilized as they are extruded. Females produce 20 to 30 capsules and each capsule contains 200 to 300 eggs. Females attach each egg capsule individually to the substrate. As spawning continues, mounds of egg capsules covering more than 100 square meters (1076 sq. ft.) may be formed.

Squid are important prey for many marine fish, birds and mammals.

Spawning is continuous and eggs of varying developmental stages may be present at one site. Temperature affects the time eggs take to hatch: 3 months at 7 to 8 °C; one month at 13 °C; and 12 to 23 days at 10 °C. Newly hatched squid are about 0.10 to 0.12 inches (2.5 to 3 mm) in length. Hatchlings are dispersed by currents, and their distribution after leaving the spawning areas is largely unknown.

Little is known about market squid abundance.

Squid feed on copepods as juveniles, gradually changing to euphausiids, other small crustaceans, small fish, and other squid as they grow. Market squid are important forage to a long list of fish, birds, and mammals. Some of the more important squid predators are king salmon, coho salmon, lingcod, rockfish, harbor seals, California sea lions, sea otters, elephant seals, Dall's porpoise, sooty shearwater, Brandt's cormorant, rhinoceros auklet and common murre. Few organisms eat squid eggs although bat stars and sea urchins have been observed doing so.

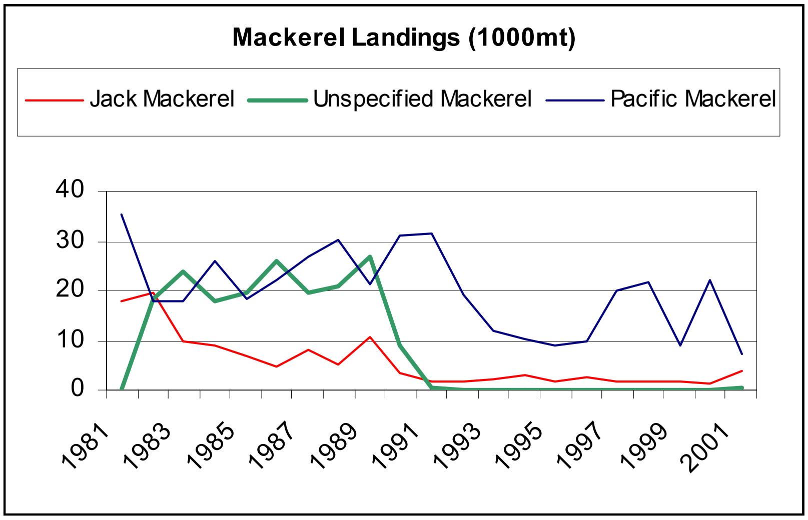


Stock Status and Trends The population dynamics of market squid are poorly understood and no reliable estimates of abundance are available (CDFG 2002; PFMC 2001). Commercial squid landings (PSMFC PacFIN reports) have fluctuated widely and have been solely determined by market demand. Recent high landings may only reflect the coincidental needs of the market and favorable environmental conditions. Similarly, very low landings may reflect unfavorable environmental conditions (PFMC 2001).

The best available information indicates squid have a very high natural mortality, approaching 100% per year, and that the adult population is composed almost entirely of new recruits. No spawner-recruit relationship has been demonstrated. Implications of these ideas are that the entire stock is replaced annually, even in the absence of fishing. Thus, the stock may be dependent on successful spawning each year coupled with good survival of recruits to adulthood (CDFG 2002).

B.2.8 Mackerels

PFMC manages mackerels off the west coast and information on the biology and status of jack mackerel and Pacific (chub) mackerel are primarily from PFMC's coastal pelagic species management plan (PFMC 1998b) and from Mason and Bishop (2001).



B.2.8.1 Jack Mackerel (*Trachurus symmetricus*)

Jack Mackerel (*Trachurus symmetricus*) is a pelagic schooling fish, widely distributed throughout the northeastern Pacific Ocean.

Jack mackerel are pelagic schooling fish, widely distributed throughout the northeastern Pacific Ocean.

Distribution and Life History Jack mackerel ranges from the Pacific coast westward to an offshore limit approximated by a line running from Cabo San Lucas, Baja California, to the eastern Aleutian Islands, Alaska. Much of their range lies outside the 200-mile US exclusive economic zone (EEZ).

Young jack mackerel (up to 6 years) school over shallow rocky banks off the Southern California Bight. Older, larger fish occur offshore in deep water and along the coastline in northern areas.

Young fish, up to six years old and 12 inches (30.5 cm) in fork length, are most abundant in the Southern California Bight and school over shallow rocky banks. Older fish, 16 to 30 years old and 20 to 24 inches (50 - 60 cm) fork length, are generally found offshore in deep water and along the coastline to the north of Point Conception. Large fish rarely appear in southern inshore waters. Fish of intermediate lengths and ages were found in considerable numbers during the spring of 1991 around the EEZ limit off southern California. Jack mackerel sampled over several years by trawl surveys off Oregon and Washington ranged from 30 to 62 cm (12 - 25 inches) and more than half were older than 20 years.

Jack mackerel can grow to two feet in length and live to 35 years or more.

Jack mackerel off southern California move inshore and offshore as well as north and south. They are more available on offshore banks in late spring, summer, and early fall than during the remainder of the year. They remain near the bottom or under kelp canopies during daylight and move into deeper nearby areas at night. Young juveniles sometimes are found in small schools beneath floating kelp and debris in the open ocean.

Jack mackerel live 35 years or more. Estimates of natural mortality are uncertain, but information suggests that approximately 20% of the stock dies each year of natural causes if no fishing occurred.

Half or more of females mature during their first year and older females may spawn every five days.

Half or more of all females reach sexual maturity during their first year of life and they are batch spawners. Older jack mackerel spawn about every five days and the average female may spawn as many as 36 times per year.

The spawning season for jack mackerel off California extends from February to October, with peak activity from March to July. Young spawners off southern California begin spawning later in the year than older spawners. Little is known of the maturity cycle of large fish offshore, but peak spawning appears to occur later in more northerly areas and far offshore.

Larval jack mackerel feed almost entirely on copepods. Small jack mackerel off southern California eat large zooplankton, juvenile squid, and anchovy. Large mackerel offshore primarily prey upon euphausiids, but also on small fishes.

Large predators like tuna and billfish and some marine mammals like seals and sea lions prey upon jack mackerel. Smaller fish and marine birds are unlikely to feed on jack mackerel, except young-of-the-year and yearlings.

Reliable estimates of jack mackerel abundance are not available.

Stock Status and Trends "The best current estimate of average spawning biomass for jack mackerel, based on California Cooperative Oceanic Fisheries Investigations (CalCOFI data), is about 1.2 million mt to 2.6 million mt, with roughly 50% of the total spawning biomass found off California and Mexico. This estimate, which is based on scanty information about the distribution and reproductive biology of jack mackerel, is little more than an educated guess"(PFMC 1998b). Beginning in 1991, in response to increased interest in fishing for jack mackerel, PFMC adopted a coastwide quota of 46,500 mt (102.5 million pounds).

Maximum sustainable yield has not been estimated but crude estimates of potential yield have been developed. These estimates for the total stock range from 130,000 to 275,000 mt (286.7 to 606.4 million pounds). Commercial landings on the U.S. west coast have been less than 5,000 mt since 1991 (see figure for mackerels above).

Pacific mackerel is a coastal pelagic species, most common south of Monterey Bay within 20 miles of shore.

B.2.8.2 Pacific (Chub) Mackerel (*Scomber japonicus*)

Pacific (Chub) Mackerel (*Scomber japonicus*) in the northeastern Pacific ranges from Banderas Bay, Mexico to southeastern Alaska and are common from Monterey Bay to Cabo San Lucas.

Distribution and Life History Pacific mackerel usually occur within 20 miles of shore, but have been taken as far offshore as 250 miles.

Of the three spawning stocks along the Pacific coasts of the US and Mexico, only the northeastern Pacific stock extending northward from Punta Abreojos, Baja California is harvested by US fishers and managed by PFMC.

Adults inhabit water ranging from 10°C to 22.2°C and they may move north in summer and south in winter between Tillamook, Oregon and Magdalena Bay, Baja California. They are found from the surface to depths of 300 meters and commonly occur near shallow banks. Juveniles are found off sandy beaches, around kelp beds, and in open bays. Larvae are found in water around 14°C. Pacific mackerel often school with other pelagic species, particularly jack mackerel and Pacific sardine.

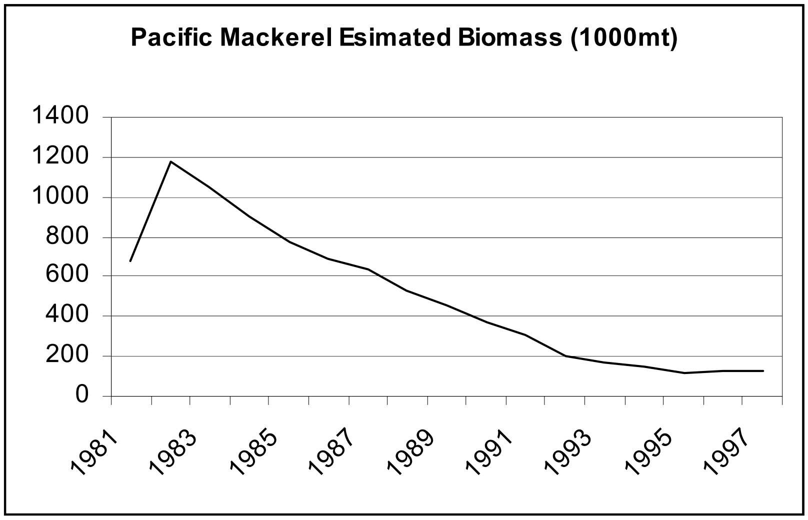
Pacific mackerel can grow to 63 cm and live to 11 years of age.

Pacific mackerel may reach 63 cm in length and 11 years in age, but most taken in commercial fisheries are less than 40 cm and four years old. Some mature as one-year-olds and all are mature by age four.

Like most coastal pelagic species, Pacific mackerel have indeterminate fecundity and seem to spawn whenever sufficient food is available and appropriate environmental conditions prevail. Spawning peaks from late April to July.

They are important prey for some groundfish, as well as marine mammals and seabirds.

Juvenile and adult Pacific mackerel prey upon small fish, fish larvae, squid and pelagic crustaceans. As larvae, they eat copepods and other zooplankton including fish larvae. Juveniles and adults are eaten by larger fish, marine mammals, and seabirds. Pacific mackerel larvae are preyed upon by a number of invertebrate and vertebrate planktivores.



Stock Status and Trends During the 1970s and 1980s, estimated biomass of Pacific mackerel rose from less than 1,000 mt in 1970 to a high of 1,176,000 mt in 1982. Biomass subsequently declined to about 125,000 mt by the late 1990s. Scale-deposition studies indicated that the period of high biomass levels was an unusual event that might be expected to occur, on average, about once every 60 years (see Soutar and Isaacs (1974) and MacCall *et al*.(1985)).

Recruitment success is highly variable and somewhat cyclic and it is estimated that mackerel might sustain average yields of 26,000 to 29,000 mt per year under current management conditions (see MacCall *et al*. (1985)).

Walleye pollock are most abundant in waters off Canada and Alaska, and only occasionally occur in sufficient numbers off the U.S. west coast to attract commercial fishing.

B.2.9 Walleye Pollock (*Theragra chalcogramma*)

are found in the waters of the Northeastern Pacific Ocean from the Sea of Japan, north to the Sea of Okhotsk, east in the Bering Sea and Gulf of Alaska, and south along the Canadian and U.S. west coast to Carmel, California. Information about walleye pollock is taken primarily from Gustafson *et al*.(2000).

Distribution and Life History Adult walleye pollock are generally a semi-demersal species that inhabit the continental shelf and slope. Adults occur as deep as 366m, but the vast majority occur between 100 and 300m. Spawning takes place at depths of 50 to 300m. Eggs are pelagic and are found throughout the water column. Larvae and juveniles are pelagic, and are generally found in the upper water column to depths of 60m. Postlarvae and small juveniles occupy a wider depth range, generally rising to the surface at night to feed and sinking down in schools during the day. Juvenile pollock have been found in a variety of habitat types, including eelgrass (over sand and mud), gravel and cobble.

Walleye pollock are not considered to be a migratory species, but prespawning adults do make relatively short migrations to regional spawning grounds. These grounds are generally in sea valleys, canyons, indentations in the outer margin of the continental shelf, and in fjords. A variety of environmental factors, including hydrographic fronts, temperature, light intensity, prey availability, and depth determine the distribution of juveniles and adults.

Walleye pollock are oviparous and females spawn several batches of eggs, usually in deep water over a short period of time. Although age of maturity varies by area, many pollock are mature by age three.

Adults are carnivorous and feed primarily on euphausiids, small fishes, copepods, and amphipods. They tend to be opportunistic feeders, preying upon whatever food items are available. In some areas, cannibalism can be an important food source for adults.

The abundance of walleye pollock off the U.S. west coast is not known.

Stock Status and Trends Little is known about the stock status and trends of walleye pollock abundance off Washington, Oregon and California. In comparison to abundance in northern waters, the numbers of walleye pollock off the west coast is low. However, in years with very favorable environmental conditions, numbers sufficient to attract attention by commercial fishers apparently move southward from waters off British Columbia.

B.2.10 Sharks

Of the more than two dozen shark species off the west coast, four species are included in this section. Three are offshore species and one is a nearshore species. Little is known about most of them, especially their population status. Information is primarily taken from the NMFS Southwest Fisheries Science Center website (SWFSC 2002) and from Leet *et al.* (1992). Three shark species, spiny dogfish, leopard shark and soupfin shark, are classified as groundfish in the FMP and are described earlier in this Appendix.

The common thresher shark is a large, pelagic species usually occurring within 40 miles of the west coast.

Annual landings data for the common thresher shark, blue shark, shortfin mako shark and Pacific angel shark are taken from the PacFIN report series.

B.2.10.1 Common Thresher Shark (*Alopias vulpinus*) is a large pelagic shark with a circumglobal distribution.

Distribution and Life History In the northeastern Pacific, it occurs from Goose Bay, British Columbia south to off Baja California. Genetic analyses indicate that the Pacific U.S.-Mexico common thresher shark is a single homogenous population. Abundance is thought to decrease rapidly beyond 40 miles from the coast, although catches off California and Oregon do occur as far as 100 miles offshore. This species is often associated with areas of high biological productivity, strong frontal zones separating regions of upwelling and adjacent waters, and strong horizontal and vertical mixing of surface and subsurface waters.

> They likely seasonally migrate between San Diego/Baja California and Oregon and Washington.

Tagging and other data suggest a seasonal north-south migration between San Diego/Baja Mexico and Oregon and Washington. Large adults may pass through southern California waters in early spring of the year, remaining in offshore waters from one to two months for pupping. Pups are then thought to move into shallow coastal waters. The adults then continue to follow warming water and perhaps prey northward, and by late summer, arrive off Oregon and Washington. Subadults appear to arrive in southern California waters during the early summer, and as summer progresses move up the coast as far north as San Francisco, with some moving as far as the Columbia River. In the fall, these subadults are thought to move south again. Little is known about the presumed southward migration of the large adults, which do not appear along the coast until the following spring.

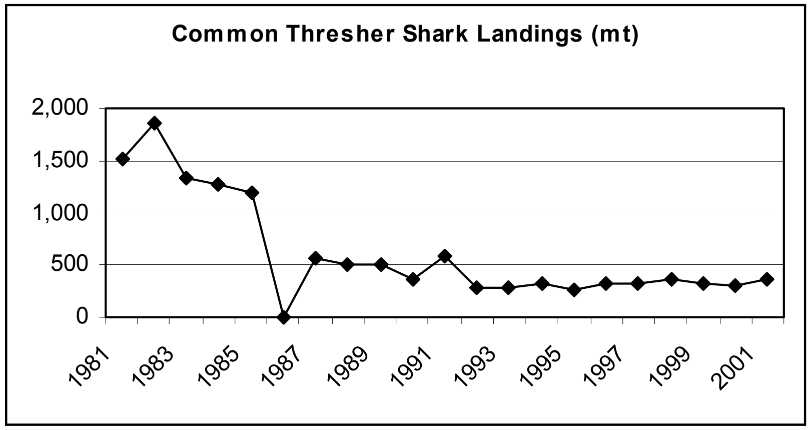
> Off the west coast, the common thresher shark grows to 18 feet in length and females mature at about 8.5-9 feet and 4-5 years of age.

Off the U.S. west coast, the largest reported is 18 feet (550 cm). Size and age of first maturity for females is likely between 8.5-9 feet (260-270 cm) and about 4 or 5 years old. For males, size and age of first maturity is between 8-11 feet (246-333 cm) and 3 to 6 years. This species has been variously reported to reach a maximum age of from 19 to 50 years old.

The common thresher shark bears live young, with a typical litter size of 2-4 pups. Mating presumably takes place in midsummer along the U.S. west coast with a gestation period of about 9 months. Birth is believed to occur in the spring months off California.

> Local thresher shark stocks may be rebuilding, following relatively heavy exploitation during the 1980s.

Primary prey items in the diet of the common thresher shark taken in the California-Oregon drift gillnet fishery included anchovy, sardine, Pacific whiting, mackerels, shortbelly rockfish, and market squid.



Status of Stocks and Trends According to preliminary analyses of trends in relative abundance in the California-based drift net fishery and fishery-independent survey data, local thresher shark stocks may be rebuilding, following the disappearance of the most heavily exploited size classes from catches during the 1980s (SWFSC 2002).

Blue sharks are oceanic and epipelagic, but may also occur at shelf narrows and near submarine canyons along the coast.

B.2.10.2 Blue Shark (*Prionace glauca*) is thought to be the most wide-ranging shark species. It is an oceanic-epipelagic species with a circumglobal distribution.

Distribution and Life History Blue sharks also occur near the coast where the shelf narrows or is cut by submarine canyons close to shore. They are most commonly found in water temperatures between 45°F and 61°F. In temperate waters, blue sharks are caught within the mixed layer and generally range between the surface and the top of the thermocline, but have been documented as deep as 2,145 feet.

Blue sharks off the west coast can grow to 8.5 feet in length and reach 20 years of age.

In the Pacific, blue shark show strong fluctuations in seasonal abundance related to population shifts northward in summer and southward in winter. There is considerable sexual segregation in populations with females more abundant at higher latitudes than males. Local abundance off California undergoes major seasonal fluctuations with juveniles to three-year-olds most abundant in the coastal waters from early spring to early winter. Mature adults are uncommon in coastal waters.

Blue sharks reportedly grow to 13 feet (396 cm) in length, but seldom exceed 8.5 feet (260 cm) off the U.S. west coast. Maximum age is reported to be at least 20 years. The size and age of 50% maturity for males is 6.5 feet (203 cm) and 4-5 years, and for females is 6 feet (186 cm) and 5-6 years.

Nursery habitat for blue sharks may extend from the Southern California Bight to the Columbia River.

Blue shark are viviparous and bear fully-formed, live young. Litters average about 30 pups, with maximum litter size reported at 135. The gestation period is about 9-12 months. Off California, parturition occurs in early spring, and mating occurs during late spring to early winter. Catch observations in the drift-net fishery suggest that the nursery habitat may extend northward to off the Columbia River mouth and primarily offshore of the 100 fm isobath.

In coastal waters off the U.S. west coast, blue sharks reportedly feed on anchovy, mackerel, whiting, dogfish, squid and pelagic crustaceans, including euphausiids. They may feed more actively at night, with highest activity in the early evening.

The status of the blue shark population is not known, but may have decreased slightly since the 1980s.

Stock Status and Trends The size of the blue shark stock off the west coast is not known. Recent analyses of trends in relative abundance in the California-based drift net fishery and fishery-independent survey data show that abundance of blue sharks has slightly decreased and fish size in the catch has also decreased since the 1980s (SWFSC 2002). The extent to which this has been influenced by shifts in environmental conditions and fish distributions is not known. Commercial landings of blue shark off the west coast have usually been less than10 mt per year.

B.2.10.3 Shortfin Mako Shark (*Isurus oxyrinchus*) is an oceanic, epipelagic species distributed in temperate and tropical seas worldwide.

The shortfin mako shark is an oceanic, epipelagic species. Off the west coast, they are most common off California.

Distribution and Life History Juveniles are also common in neritic waters. In the eastern Pacific, the mako shark occurs from Chile to the Columbia River and in U.S. west coast waters is most common off California.

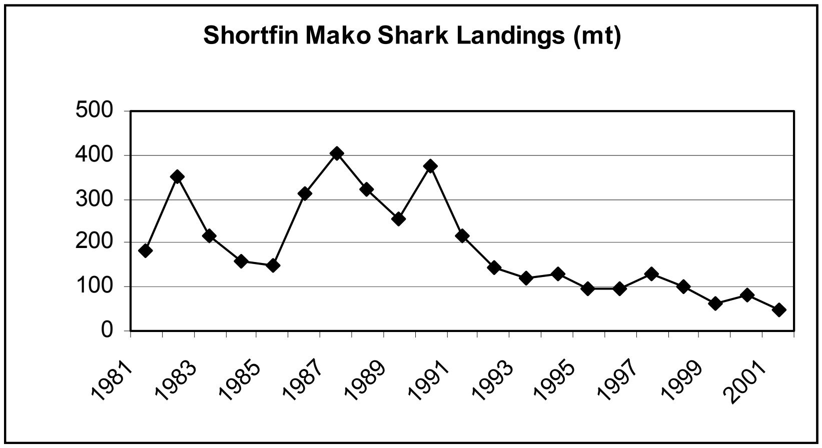
The Southern California Bight is an important pupping and nursery area for shortfin mako sharks.

Off the west coast, shortfin mako sharks grow up to 11.5 feet (351 cm); those caught are typically between 6-7 feet (213-244 cm) in length. Determining the age of shortfin mako sharks is difficult, but the maximum age may be as old as 40 years. They bear live young, with an average brood size of about 12 pups, but litters from 4 to 30 have been reported. At birth, pups are about 2.0 to 2.5 feet in length. The gestation period is estimated to last from 12 to 19 months.

The present status of the shortfin mako shark is not known, but is of concern.

Tagging data suggest that the Southern California Bight is an important pupping and nursery area. Newly born juveniles apparently remain in these waters for about two year, then move offshore or to the south.

Shortfin mako sharks may feed predominantly during the day and important prey includes mackerel, bonito, anchovy, tuna, marine mammals, marlin, other sharks and squid off California (SWFSC 2002).



Stock Status and Trends The present status of the shortfin mako shark in state and federal waters off California is not known but is of concern. Over-development of fisheries in the coastal nursery poses the greatest risk to the mako population in the eastern Pacific. Recent analyses of trends in relative abundance in the California-based drift net fishery and fishery-independent survey data show that abundance of shortfin mako sharks has slightly decreased and fish size in the catch has also decreased since the 1980s (SWFSC 2002). The extent to which this has been influenced by shifts in environmental conditions and fish distributions is not known.

Pacific angel sharks live on sandy bottoms along the west coast, commonly at depths between 30 and 240 feet off California.

B.2.10.4 Pacific Angel Shark (*Squatina californica*) in the northeastern Pacific Ocean occurs from southeastern Alaska to the Gulf of California, although they are uncommon north of California.

Distribution and Life History The angel shark is a relatively small, bottom-dwelling shark, living on the sandy bottom of the ocean, commonly at depths between 30 and 240 feet. It lives offshore to depths of over 600 feet, in bays, and along the fringe of kelp forests. It is often found laying partially buried on sandy bottoms in sand channels between rocky reefs during the day, and appears to move little away from its home territory. Research strongly indicates that genetically isolated populations of angel sharks exist in California.

Genetic studies suggest that isolated populations of angel sharks exist in California waters.

Pacific angel sharks reach a maximum length of five feet and a weight of 60 pounds. To date, attempts to determine the age of angel sharks have been unsuccessful. Sexual maturity in both males and females occurs between 35 and 39 inches in length. An average of six pups are produced annually from March to June. A 10-month gestation period is estimated for this species.

The angel shark's diet varies seasonally. Major prey items include queenfish and blacksmith in the summer and market squid in the winter. They also reportedly prey upon mackerel and sardines during the fall and early winter.

The current status of the population is not known.

Stock Status and Trends No population studies have been conducted on angel shark since the commercial nearshore fishery off California ended in 1994. Commercial fishing for angel shark rose during the 1980s to a peak of 1,132 mt in1985. Reduced catches subsequently resulted from changing fishing practices and a series of management actions implemented out of concern for the status of the population during the late 1980s. Annual commercial landings reported in the PacFIN data series have remained below 60 mt since 1993.

Many herring stocks occur along the Pacific coast from Mexico to Alaska.

B.2.11 Pacific Herring (*Clupea pallasi*) range from Baja California to Alaska and across the Pacific Ocean to Japan, China, and Russia. Information on the distribution and life history of Pacific herring was drawn from the following sources: Watters *et al* (2001), Lassuy (1989), Barnhart(1988), and McCrae (1994b).

Distribution and Life History Juvenile herring form schools and inhabit inshore waters until summer or early fall when they migrate to the open ocean. There is little information on the life history of herring in the ocean.

Herring consistently spawn in the same areas from year to year and each spawning area is typically managed as a separate stock.

There may be numerous herring stocks although individual ones have not been clearly defined. Many differences have been found between stocks at different latitudes, such as timing of spawning, age at maturity, and size. Locations of spawning grounds are consistent from year to year and each spawning area is typically managed as a separate stock. It is likely that stocks intermingle extensively on summer offshore feeding grounds.

Herring spawn on marine vegetation or rocky substrate in protected inlets, bays, and estuaries.

Some herring reach sexual maturity at age two and all are sexually mature by age three. Pacific herring off California may live to be nine or 10 years old and reach a maximum length of about 11 inches (28 cm), although fish older than seven are rare (Watters *et al.* 2001).

Spawning habitats are typically marine vegetated or rocky substrate in protected inlets, bays, and estuaries, from intertidal to about 30 feet (9 m) in depth. Very little spawning occurs on the open coast.

Spawning times vary with latitude and apparently coincide with increasing plankton productivity. Spawning can begin as early as October in California, and as late as July in Alaska. Spawning peaks in February and March off Oregon. In the late winter and early spring, large schools of herring enter shallow bays and estuaries, where they remain up to three weeks before spawning. Spawning occurs in "waves" of 1-3 days, separated by 1-2 weeks between waves. Larger, older fish tend to spawn first, then smaller, younger fish.

> A large spawning run can result in 20 miles or more of the shoreline being covered by a 30-foot-wide band of herring eggs.

A large female may lay 40,000-50,000 eggs in one year. Eggs are laid in thin layers or up to 20 layers thick on vegetation or solid substrates. The highest egg densities are in the lower intertidal and upper subtidal zones. A large spawning run may last a week and can result in 20 miles (32.2 km) or more of the shoreline being covered by a 30-foot-wide (9.1-m-wide) band of herring eggs.

> Pacific herring is one of the most important prey species for other marine fish, birds, mammals, and invertebrates.

Eggs are vulnerable to predation by marine birds, fishes, and invertebrates and to desiccation or freezing during low tide cycles. Between 50-99 % of herring eggs die during the 2 to 3 weeks till hatching.

Copepods, euphausiids, and decapod larvae are major food items for herring. Herring are an important forage fish for numerous species of marine fishes, birds, invertebrates, and mammals.

Stock Status and Trends Coastwide estimates of herring abundance are not available, but the size of herring spawning populations in Tomales and San Francisco Bays is estimated annually. During 2000, spawning biomass was estimated at 27,400 tons (60.4 million pounds) in San Francisco Bay and 2,011 tons (4.4 million pounds) in Tomales Bay.

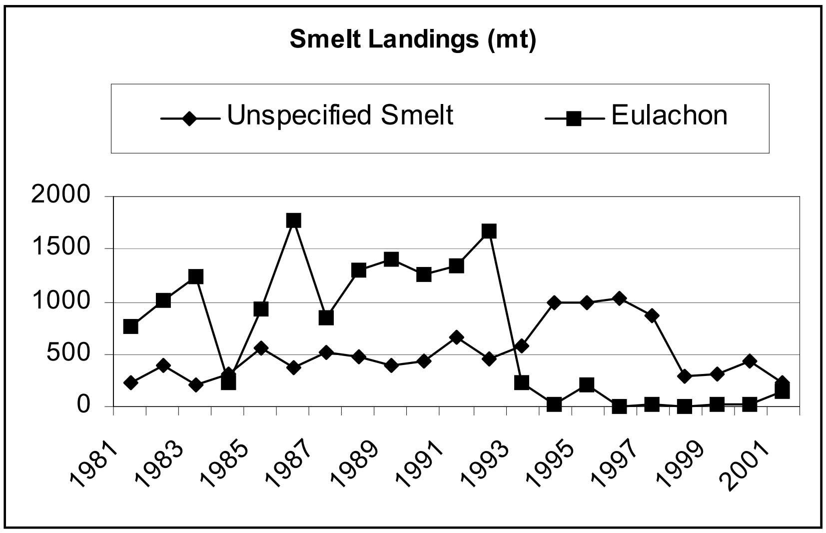
Annual abundance fluctuates widely due to variations in recruitment caused by environmental factors, especially El Niño events. The lack of upwelling and associated warm water conditions that occur during El Niño events reduces the production of food for herring, which can affect their condition and survival. It also may displace herring to areas of colder water.

B.2.12 Smelts

Little is known about smelt abundance on the west coast.

Smelts off the west coast are managed by the respective state agencies and Washington treaty tribes. Information about true smelts is taken from: Sweetnam *et al*.(2001), Wang(1986), and McCrae (1994c). Four species are summarized in this section: longfin smelt, night smelt, surf smelt, and eulachon, also known as Columbia River smelt.

Little is known about the abundance of smelts along the west coast. Annual commercial landings of smelt, primarily eulachon, are from the annual reports of the PacFIN data series.



B.2.12.1 Eulachon (*Thaleichthys pacificus)* range from central California to Alaska.

Eulachon are pelagic, schooling fish and spend most of their life in the open ocean.

Distribution and Life History Eulachon are anadromous, spending most of their life in the open ocean, schooling at depths of 150 to 750 feet (46 - 229 m). They migrate to lower reaches of coastal rivers and streams to spawn in fresh water; occasionally they travel over 100 miles up the Columbia River. They spawn in gravelly riffles close to the stream mouths.

They travel to the lower reaches of rivers and streams to spawn in freshwater.

Eulachon may live up to five years and reach 12 inches (30.5 cm) in length. Most eulachon reach maturity in two to three years and die after spawning. Each female lays about 25,000 eggs which stick to the gravel and hatch in two to three weeks. Upon hatching, larvae begin migrating to the sea.

Eulachon feed mainly on euphasiids, copepods and othe curstaceans, and they are a very important food for predatory marine animals, including salmon, halibut, cod and sturgeon.

Eulachon abundance coastwide declined drastically during the late 1990s.

Stock Status and Trends In recent years, eulachon numbers have declined drastically. Although coastwide commercial landings of eulachon usually exceeded 1,000 mt during the 1980s and early 1990s, they were less than 26 mt each year between 1996 and 2000 (see figure for smelts above). In 2001, the Columbia River spawning run increased and may be a harbinger of larger stock sizes in the future (WDFW 2002).

Eulachon numbers in California rivers also declined drastically in recent years. They are now rare or absent from the Mad River and Redwood Creek and scarce in the Klamath River (Sweetnam *et al.* 2001).

Longfin smelt are pelagic and primarily inhabit estuaries.

B.2.12.2 Longfin Smelt (*Spirinchus thaleichthys*) is a pelagic, estuarine fish, which ranges from Monterey Bay, California to Prince William Sound, Alaska.

At age two, they migrate to freshwater to spawn, then most die.

Distribution and Life History Longfin smelt are anadromous and live up to three years. They reach lengths of six inches (15 cm). Longfin smelt reach maturity at the end of their second year. Most die after spawning, but a few females may survive and spawn a second time. Females produce between 5,000 and 24,000 eggs, which are adhesive and attach to the substrate. Hatching takes place within 40 days depending on water temperature.

In the Sacramento-San Joaquin Estuary, adults feed mainly on mysids, while juveniles prefer copepods. Potential predators include striped bass, inland silversides, marine birds and some marine mammals.

Stock Status and Trends Abundance of longfin smelt severely declined in California during the early 1990s. However, the populations in California are not considered genetically distinct from abundant and stable populations found in Washington (Sweetnam *et al.* 2001).

Unlike longfin smelt, night smelt are uncommon in estuaries and occupy coastal areas.

B.2.12.3 Night Smelt (*Spirinchus starksi*) are found from Point Arguello, California to Shelikof Bay, Alaska.

Night smelt congregate to spawn on shallow beaches with coarse sand and gravel and become completely buried in the surf zone.

Distribution and Life History Night smelt are schooling, plankton-feeding fish. Apparently, the bulk of the population remains along the Pacific coast, and only a few occasionally enter bays and estuaries (Wang 1986).

Night smelt rarely exceed 3 inches (7.6 cm) in length or three years in age. Spawning has been recorded from January through

September on the same beaches as those used by surf smelt. During spawning, schools of fish congregate on shallow beaches with coarse sand and gravel. The adhesive eggs sink to the bottom, become encrusted by sand and gravel, and eventually become completely buried in the substrate in the surf zone. Adults may spawn more than once during the season. Eggs take about two weeks to hatch. Life history details from the egg to the juvenile stages are not well known.

Their diet consists of small crustaceans, similar to that of other smelt. Night smelt are also important prey for other fishes as well as marine mammals and birds.

Stock Status and Trends Little is known about the status of the night smelt population, although commercial landings in California averaged over 800,000 pounds (363 mt) per year during the 1990s (Sweetnam *et al.* 2001). Its population status off Oregon and Washington is not known.

B.2.12.4 Surf Smelt (*Hypomesus pretiosus*) have been reported to occur from Prince William Sound and Chignik Lagoon, Alaska to Long Beach, California, although they are only common north of San Francisco Bay.

Surf smelt are most common north of San Francisco Bay and generally stay within ten miles of shore.

Distribution and Life History Surf smelt are a schooling, plankton-feeding fish that can reach 10 inches (25.4 cm) in length. Females typically grow the largest and live the longest, up to five years. Males rarely live longer than three years. Females are mature in one to two years, and produce 1,300 to 37,000 eggs.

Surf smelt spawn on selected beaches at predictable times of the day and year. In California, most spawning occurs in June through September, especially during high tides. The fertilized eggs stick to sand and pebbles and they appear to prefer beaches made up largely of coarse sand and gravel, with some freshwater seepage. During periods of heavy spawning, some beaches are coated with eggs. Juveniles commonly inhabit estuaries during spring through fall.

Surf smelt spawn on selected beaches at predictable times of the year, especially during high tides.

Eggs hatch in two to three weeks. Little is known about their life history as larvae, juveniles or adults in the ocean environment. They generally stay within ten miles of shore.

Surf smelt are important prey for many marine birds, mammals and fishes.

Stock Status and Trends Little information is available about the population status of surf smelt on the west coast.

Marine Mammals, Turtles, and Seabirds

A.3 Marine Mammals, Turtles and Seabirds

B.3.1 Introduction

This section examines interactions between protected species and groundfish fisheries under consideration in this Fishery Management Plan (FMP). As a point of clarification, interactions and incidental catches are different than bycatch. Interactions and incidental catches involve fishing gears and marine mammals, turtles and birds, while bycatch consists of regulatory or economic discards of fish. Turtles, although defined as fish in the Magnuson-Stevens Act and thus technically are bycatch, are included in this section because of their protected status (NMFS 1998). The marine mammal species accounts presented here are taken primarily from the most recent Stock Assessment Reports (Carretta *et al.* 2001) prepared by NMFS as required by the Marine Mammal Protection Act (MMPA). The sea turtle species accounts are taken from the species accounts of the Environmental Assessment for the issuance of a marine mammal permit to the California/Oregon drift gillnet fishery (NMFS 2001a).

The following marine mammal species occur off the west coast that are or could be of concern with respect to potential interactions with groundfish fisheries.

	Scientific Name	ESA Status
Pinnipeds		
California sea lion	*Zalophus californianus*	
Pacific harbor seal	*Phoca vitulina richardsi*	
Northern elephant seal	*Mirounga angustirostris*	
Guadalupe fur seal	*Arctocephalus townsendi*	T
Northern fur seal	*Callorhinus ursinus*	
Northern or Steller sea lion	*Eumetopias jubatus*	T
Sea otters		
Southern	*Enhydra lutris nereis*	T
Washington	*Enhydra lutris kenyoni*	
Cetaceans		
Minke whale	*Balaenoptera acutorostrata*	
Short-finned pilot whale	*Globicephala macrorhyncus*	

Gray Whale	*Eschrichtius robustus*	
Harbor porpoise	*Phocoena phocoena*	
Dall's porpoise	*Phocoenoides dalli*	
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	
Short-beaked common dolphin	*Delphinus delphis*	
Long-beaked common dolphin	*Delphinus capensis*	

The following cetaceans are present within the area managed by this FMP but not likely to interact with groundfish fisheries or have not been documented having had interactions in observed groundfish fisheries:

Bottlenose dolphin	*Tursiops truncatus*	
Striped Dolphin	*Stenella coeruleoalba*	
Sei whale	*Balaenoptera borealis*	E
Blue whale	*Balaenoptera musculus*	E
Fin whale	*Balaenoptera physalus*	E
Sperm whale	*Physeter macrocephalus*	E
Humpback whale	*Megaptera novaeangliae*	E
Bryde's whale	*Balaenoptera edeni*	
Sei whale	*Balaenoptera*	E
Killer whale	*Orcinus orca*	
Baird's beaked whale	*Berardius bairdii*	
Cuvier's beaked whale	*Ziphius cavirostris*	
Pygmy sperm whale	*Kogia breviceps*	
Risso's dolphin	*Grampus griseus*	
Striped dolphin	*Stenella coeruleoalba*	
Northern right-whale dolphin	*Lissodelphis borealis*	

The following sea turtle species occur off the west coast that are or could be of concern with respect to potential interactions with groundfish fisheries.

	Scientific Name	ESA Status
Loggerhead	*Caretta caretta*	T
Green	*Chelonia mydas*	T
Leatherback	*Dermochelys coriacea*	E
Olive (Pacific) ridley	*Lepidochelys olivacea*	T

The following seabirds occur off the west coast that are or could be of concern with respect to potential interactions with groundfish fisheries.

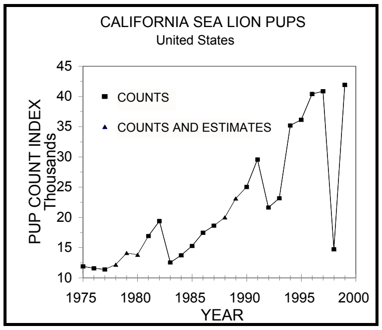
	Scientific Name	ESA Status
Short-tailed albatross	*Phoebastria albatrus*	E
Black-footed albatross	*Phoebastria nigripes*	
California brown pelican	*Pelecanus occidentalis californicus*	E
Northern fulmar	*Fulmarus glacialis*	

Cormorants	*Phalacrocorax* species
Puffins	*Fratercula* species
Shearwaters	*Puffinus* species
Gulls	*Larus* species

B.3.2 Marine Mammals

B.3.2.1 California Sea Lion *(Zalophus californianus)*

B.3.2.1 California Sea Lion *(Zalophus californianus)* range from British Columbia south to Tres Marias Islands off Mexico. Breeding grounds are mainly on offshore islands from the Channel Islands south into Mexico. Breeding takes place in June and early July within a few days after the females give birth. NMFS conducts annual pup censuses at established rookeries (Lowry 1999) and uses a correction factor to obtain a total estimated population of 214,000 sea lions (Carretta *et al.* 2001). The stock appears to be increasing at about 6.2% per year while fishery mortality also is increasing (Lowry *et al.* 1992). California sea lions are not endangered or threatened under the Endangered Species Act (ESA) nor depleted under the MMPA. This stock is also not listed as a strategic under the MMPA and total human-caused mortality (1352 sea lions) is less than the 6,591 sea lions allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

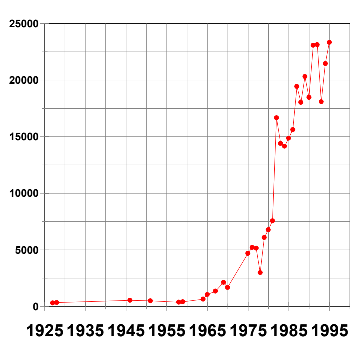


The US pup counts continue to increase (From Lowry, 1999; Carretta, 2001).

California sea lions are killed incidentally in the California set gillnet and CPFV fisheries and also the WOC groundfish trawl fishery.

During the summer breeding season, most adults are present near rookeries principally located on the southern California Channel Islands and Año Nuevo Island near Monterey Bay. Males migrate northward in the fall, going as far north as Alaska and returning to their rookeries in the spring. Adult females generally do not migrate far away from rookery areas. Juveniles remain near rookery areas or move into waters off central California. Diet studies indicate that California sea lions feed on squid, octopus, and a variety of fishes: anchovies, sardine, mackerel, herring, rockfish, hake, and salmon (Antonelis *et al.* 1984; Lowry *et al.* 1990; NMFS 1997).

Incidental mortalities of California sea lions have been documented in set and drift gillnet fisheries (Carretta *et al.* 2001; Hanan *et al.* 1993). Skippers logs and at-sea observations have shown that California sea lions have been incidentally killed in Washington, Oregon, and California groundfish trawls and during Washington, Oregon, and California commercial passenger fishing vessel fishing activities (Carretta *et al.* 2001).



Increases in CA Harbor Seals (Hanan, 1996)

B.3.2.2 Harbor Seal *(Phoca vitulina richardsi)*

inhabit nearshore and estuarine areas ranging from Baja

California, Mexico, to the Pribilof Islands, Alaska. MMPA stock assessment reports recognize six stocks along the U.S. west coast: California, Oregon/ Washington outer coastal waters, Washington inland waters, and three stocks in Alaska coastal and inland waters (Carretta *et al.* 2001). Using the latest complete aerial survey (Hanan 1996) and appropriate corrections for counting bias, Carretta, *et al.* (2001) estimates the California stock at 30,293 seals; the Oregon/ Washington Coast stock at 26,180 seals; and the Washington inland-water stock at 16,056 seals. These estimates combine for a west coast, lower three-state total of 72,529 seals. The population appears to be growing and fishery mortality is declining. Harbor seals are not endangered or threatened under the ESA nor depleted under the MMPA. This stock is also not listed as a strategic under the MMPA and total human-caused mortality (666 seals) is less than the 1,678 harbor seals allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

Harbor seals do not migrate extensively, but have been documented to move along the coast between feeding and breeding locations (Brown 1988; Herder 1986; Jeffries 1985). The harbor seal diet includes herring, flounder, sculpin, cephalopods, whelks, shrimp, and amphipods (Bigg 1981; NMFS 1997).

No mortalities of harbor seals have been observed in west coast groundfish fisheries.

Combining mortality estimates from California set net, northern Washington marine set gillnet, and groundfish trawl results in an estimated mean mortality rate in observed groundfish fisheries of 667 harbor seals per year along Washington, Oregon, and California (Carretta *et al.* 2001).

B.3.2.3 Northern Elephant Seal *(Mirounga angustirostris*)

range from Mexico to the Gulf of Alaska. Breeding and whelping occurs in California and Baja California, during winter and early spring (Stewart and Huber 1993)on islands and recently at some mainland sites. Stewart *et al.*(1994) estimated the population at 127,000 elephant seals in the U.S. and Mexico during 1991. The population is growing and fishery mortality may be declining, and the number of pups born may be leveling off in California during the last five years (Carretta *et al.* 2001). Northern elephant seals are not endangered or threatened under the ESA nor depleted under the MMPA. This stock is also not listed as a strategic under the MMPA and total human-caused mortality (33 seals) is less than the 2,142 elephant seals allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

The northern elephant seal is not ESA of MMPA listed, and population is growing.

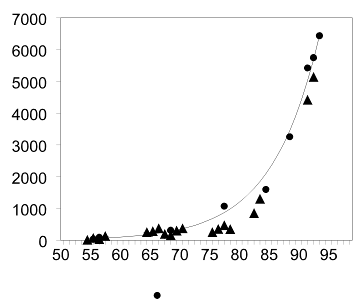
Northern elephant seals are polygynous breeders with males forming harems and defending them against other mature males in spectacular battles on the beach. Female give birth in December and January, mate about three weeks later, after which the pups are weaned (Reeves *et al.* 2002). They were hunted for their oil to near extinction and the current population is composed of the decedents of a few hundred seals that survived off Mexico (Stewart *et al.* 1994). They feed mainly at night in very deep water to consume whiting, hake, skates, rays, sharks, cephalopods, shrimp, euphasiids, and pelagic red crab (Antonelis *et al.* 1987). Males feed in waters off Alaska, and females off Oregon and California (Le Boeuf *et al.* 1993; Stewart and Huber 1993).

Elephant seals eat whiting, skates, rays, sharks, and other species.

There are no recent estimated incidental kills of Northern elephant seals in groundfish fisheries along Washington, Oregon, and California, however they have been caught in setnet fisheries (Carretta *et al.* 2001).

B.3.2.4 Guadalupe Fur Seal *(Arctocephalus townsendi)*

historical distribution and abundance are uncertain because commercial sealers and other observers failed to distinguish between this species and the northern fur seals. However, the species likely ranged from Islas Revillagigedo, Mexico (18° N) to Point Conception, California (34° N) and possibly as far north as the Farallon Islands, California (37° N). At the present time, this species ranges from Cedros Island, Mexico to the northern Channel Islands. Remains have been found in Indian trash middens through out the southern California bight and individual seals frequent Channel Island sea lion colonies (Stewart *et al.* 1987). This species was once thought to be extinct, however Gallo(1994)estimated a total of about 7,408 animals in 1993, and a growth rate of about 13.7% per year (Carretta *et al.* 2001). Guadalupe fur seals are protected under Mexican law (Guadalupe Island is a marine sanctuary), the U.S. MMPA (depleted and strategic), U.S. ESA (threatened), the California Fish and Game Code (fully protected), and the California Fish and Game Commission (threatened).



Counts of Guadalupe fur seals have increased dramatically (from Carretta, 2001 #25).

There have been no U.S. reports of fishing-related mortalities or injuries for Guadalupe fur seals.

In 1892, only 7 of these seals could be found; they were presumed extinct until 1926, when a group of 60 animals was discovered on Isla de Guadalupe, Mexico (Hubbs and Wick 1951). Although the primary breeding colony is on Guadalupe Island, Mexico, a pup was born at San Miguel Island, California (Melin and DeLong 1999). Males defend territories during May through July and mate with the females approximately one week after the birth of single pups. Guadalupe fur seals are reported to feed on fish including hake, rockfish, and cephalopods (Fleischer 1987) and probably require about 10% of their own body weight in fish per day.

There have been no U.S. reports of mortalities or injuries for Guadalupe fur seals (Cameron and Forney 1999; Julian 1997; Julian and Beeson 1998), although there have been reports of stranded animals with net abrasions and imbedded fish hooks (Hanni *et al.* 1997).

B.3.2.5 Northern Fur Seal *(Callorhinus ursinus)*

range in the eastern north Pacific Ocean, from southern California to the Bering Sea. Two separate stocks of northern are recognized within U.S. waters: an Eastern Pacific stock and a San Miguel Island stock. Nearly hunted to extinction for its fur, the San Miguel Island stock is estimated at 4,336 seals (Carretta *et al.* 2001) and the Eastern Pacific stock at 941,756 seals (Angliss and Lodge 2002). The San Miguel Island stock is not endangered or threatened under the ESA nor depleted under the MMPA. This stock is also not listed as a strategic under the MMPA and total human-caused mortality (0 seals) is less than the 100 fur seals allowed under the Potential Biological Removal formula (Carretta *et al.* 2001). "The Eastern Pacific stock is classified as a strategic because it is designated as depleted under the MMPA" (Angliss and Lodge 2002).

Prior to harvesting, Northen fur seal populations were mainly located on the Pribilof Islands of Alaska, and were estimated at two million animals. Northern fur seals were harvested commercially from the 1700s to 1984. San Miguel Island is the only place in California where northern fur seals breed and pup. Offshore, they dive to depths of 20 - 130 m, usually at night, to feed opportunistically on pollock, herring, lantern fish, cod, rockfish, squid, loons, and petrels (Fiscus 1978; Gentry 1981; Kajimura 1984; Kooyman *et al.* 1976).

Fur seals are a pelagic species spending many months at sea migrating throughout the eastern North Pacific Ocean including off Oregon and California (Roppel 1984). There were no reported mortalities of northern fur seals in any observed fishery along the west coast of the continental U.S. during the period 1994-1998 (Carretta *et al.* 2001), although there were incidental mortalities in trawl and gillnet fisheries off Alaska (Angliss and Lodge 2002).

Steller sea lions are listed as threatened under the ESA.

B.3.2.6 Northern or Steller sea lion

(Eumetopias jubatus) range along the North Pacific Ocean from Japan to California (Loughlin *et al.* 1984). Two stocks are designated in U.S. waters with the eastern stock extending from Cape Suckling, Alaska to southern California (Loughlin 1997) with a total of 6,555 animals off Washington, Oregon and California. The eastern stock of Steller sea lion has a threatened listing under the ESA, depleted under the MMPA, and therefore is classified as a strategic stock (Angliss and Lodge 2002).

They do not make large migrations, but disperse after the breeding season (late May-early July), feeding on rockfish, sculpin, capelin, flatfish, squid, octopus, shrimp, crabs, and northern fur seals (Fiscus and Baines 1966).

Eastern stock Steller sea lions were observed taken incidentally in WA/OR/CA groundfish trawls and marine set gillnet fisheries (Angliss and Lodge 2002). Total estimated mortalities of this stock (44) is less than the 1,396 Steller sea lions allowed under the Potential Biological Removal formula (Angliss and Lodge 2002).

Harvest of sea otters during the 1700s and 1800s reduced the species to near extinction throughout its range.

B.3.2.7 Southern Sea Otter *(Enhydra lutris*

nereis) range along the mainland coast from Half Moon Bay, San Mateo County south to Gaviota, Santa Barbara County; an experimental population currently exists at San Nicolas Island, Ventura County (VanBlaricom and Ames 2001). Prior to the harvest that drove the population to near extinction, sea otters ranged from Oregon to Punta Abreojos, Baja California (Wilson *et al.* 1991). The 2002 spring survey of 2,139 California sea otters reflects an overall decrease of 1.0 percent from the 2001 spring survey of 2,161 individuals, according to scientists at the U.S. Geological Survey. Observers recorded 1,846 independents in 2002 (adults and subadults), down 0.9 percent from the 2001 count of 1,863 independents; 293 pups were counted in 2002, down by 1.7 percent from the 2001 count of 298 pups (USGS 2002). The U.S. Fish and Wildlife Service declared the southern sea otter a threatened species in 1977 under the ESA and therefore the stock is also designated as depleted under the MMPA (VanBlaricom and Ames 2001).

The California population of southern sea otters is listed as threatened.

Harvest for their fur reduced the sea otter population to very few animals and presumed extinction until California Department of Fish and Game biologists and wardens discovered a remnant group near Point Sur. In 1914, the total California population was estimated to be about 50 animals (CDFG 1976). Sea otters eat large-bodied bottom dwelling invertebrates such as: sea urchins, crabs, clams, mussels, abalone, other shellfish, as well as, market squid. Otters can dive up to 320 feet to forage (VanBlaricom and Ames 2001).

During the 1970s and 1980s considerable numbers of sea otters were observed caught in gill and trammel entangling nets in central California. This was projected as a significant source of mortality for the stock until gill nets were prohibited within their feeding range. During 1982 to 1984 an average of 80 sea otters were estimated to drown in gill and trammel nets (Wendell *et al.* 1986). More recent mortality data (Pattison *et al.* 1997) suggest similar patterns during a period of increasing trap and pot fishing for groundfish and crabs (Estes *et al.* In Press). This elevated mortality appears to be the main reason for both sluggish population growth and periods of decline in the California sea otter population (Estes *et al.* In Press).

Sea otters were reintroduced off Washington in 1969-1970.

B.3.2.8 Sea Otter *(Enhydra lutris kenyoni*, Washington stock) range from Pillar Point south to Destruction Island. In an effort to return the extirpated sea otters to Washington state waters, otters were transplanted from Amchitka Island, Alaska in 1969 and 1970; 59 otters were introduced (Jameson *et al.* 1982). The experiment worked, sea otter numbers increased, and they are re-occupying former range (Richardson and Allen 2000). The highest count for the 2001 survey was 555 sea otters, an increase of 10% from 2000 (USGS 2002). The rate of increase for this population since 1989 is about 8.8%. The Washington sea otter has no formal Federal listing under ESA or MMPA but is designated as endangered by the State of Washington.

The Washington sea otter stock ranges from Neah Bay south to Destruction Island.

Sea otters eat bottom dwelling invertebrates such as: sea urchins, crabs, sea cucumbers, clams, mussels, abalone, other shellfish, as well as, market squid. Otters can dive up to 320 feet to forage (VanBlaricom and Ames 2001).

Gillnet and trammel net entanglements were a significant source of mortality for southern sea otters (Wendell *et al.* 1986) and some sea otters were taken incidentally in setnets off Washington (Kajimura 1990). Evidence from California and Alaska suggests that incidental take of sea otter in crab pots and tribal set-net fisheries may also occur. Sea otters are also quite vulnerable to oil spills due to oiled fur interfering with thermoregulation, ingested oil disintegrating the intestinal track, and inhaled fumes eroding the lungs (Richardson and Allen 2000).

Harbor porpoise are not listed under the ESA or MMPA.

B.3.2.9 Harbor Porpoise *(Phocoena phocoena)*

are small and inconspicuous. They range in nearshore waters from Point Conception, California into Alaska and do not make large scale migrations (Gaskin 1984). Harbor porpoise in California are split into two separate stocks based on fisheries interactions: the central California stock, Point Conception to the Russian River, and the northern California stock in the remainder of northen California (Barlow and Hanan 1995). Oregon and Washington harbor porpoise are combined into a coastal stock and there is designated an inland Washington stock for inland waterways. The most recent abundance estimates, based on aerial surveys are: central California 7,579; northern California 15,198; Oregon/ Washington coastal 44, 644; and inland Washington 3,509 harbor porpoise. There are no clear trends in abundance for these stocks (Carretta *et al.* 2001). Harbor porpoise are not listed as threatened or endangered under the ESA nor as depleted under the MMPA. "The average annual mortality for 1996-99 (80 harbor porpoise) is greater than the calculated PBR (56) for central California harbor porpoise; therefore, the central California harbor porpoise population is strategic under the MMPA" (Carretta *et al.* 2001).

Although usually found in nearshore waters, "distinct seasonal changes in abundance along the west coast have been noted, and attributed to possible shifts in distribution to deeper offshore waters during late winter" (Barlow 1988; Carretta *et al.* 2001; Dohl *et al.* 1983). The harbor porpoise diet is comprised mainly of cephalopods and fishes and they prefer schooling non-spiny fishes, such as herrings, mackerels, and sardines (Reeves *et al.* 2002).

Harbor porpoise are very susceptible to incidental capture and mortalities in setnet fisheries (Julian and Beeson 1998). Off Oregon and Washington, fishery mortalities of harbor porpoise have been recorded in the northern Washington marine set and drift gillnet fisheries (Carretta *et al.* 2001).

Dall's porpoises have not been listed under the ESA or MMPA.

Low levels of mortality for Dall's porpoise have also been documented in the California/Oregon/ Washington domestic groundfish trawl fisheries.

B.3.2.10 Dall's Porpoise *(Phocoenoides dalli)*

are common in shelf, slope and offshore waters in the north eastern Pacific Ocean down to southern California (Morejohn 1979). As a deep water oceanic porpoise, they are often sighted nearshore over deep-water canyons. These porpoise are abundant and widely distributed with at least 50,000 off California, Oregon, and Washington; however because of their behavior of approaching vessels at sea, it may be difficult to obtain an unbiased estimate of abundance (Reeves *et al.* 2002). They are not endangered or threatened under the ESA nor depleted under the MMPA. This stock is also not listed as strategic under the MMPA and total human-caused mortality (12) is less than the 737 porpoise allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

Dall's porpoise calf between spring and fall after a 10-11 month gestation period (Reeves *et al.* 2002). Carretta, *et al*. (2001)observe "that north-south movement between California, Oregon and Washington occurs as oceanographic conditions change, both on seasonal and inter-annual time scales." Dall's porpoise feed on squid, crustaceans, and many kinds of fish including jack mackerel (Leatherwood *et al.* 1982; Scheffer 1953).

There is a harpoon fishery for Dall's porpoise in Japan where large numbers are killed (Reeves *et al.* 2002). Observers document that Dall's porpoise have been caught in the California, Oregon and Washington domestic groundfish trawl fisheries (Perez and Loughlin 1991) but the estimated annual take is less than two porpoise per year.

B.3.2.11 Pacific White-sided Dolphin

(Lagenorhynchus obliquidens) are abundant, gregarious and found in the cold temperate waters of the North Pacific Ocean. Along the west coast of north America they are rarely observed south of Baja California, Mexico. Aerial surveys have exceeded 100,000 white-sided dolphins over the California continental shelf and slope waters (Reeves *et al.* 2002). These dolphins are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (7) is less than the 157 dolphins allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

> Low levels of white-sided dolphin mortality have been documented in the Pacific whiting fishery.

Little is know of their reproductive biology although a 29 year old pregnant female is reported indicating a relatively long reproductive span (Reeves *et al.* 2002). White-sided dolphins inhabit California waters during winter months moving northward into Oregon and Washington during spring and summer (Green *et al.* 1992). Shifts in abundance likely represent changes in prey abundance or migration of prey species. They are opportunistic feeders and often work collectively to concentrate and feed small schooling fish including anchovies, hakes, herrings, sardines, and octopus.

Observers have documented mortalities in the California, Oregon, and Washington groundfish trawl fisheries for whiting (Perez and

Loughlin 1991). The total estimated kill of white-sided dolphins in these fisheries averages less than one dolphin per year (Carretta *et al.* 2001).

Risso's dolphins have not been listed under ESA or MMPA.

B.3.2.12 Risso's Dolphin (*Grampus griseus*)

have world-wide distribution in warm-temperate waters of the upper continental slope in waters depths averaging 1,000 feet. They commonly move into shallow areas in pursuit of squid (Reeves *et al.* 2002). Reeves *et al.*(2002) also report up to 30,000 Risso's dolphins off the U.S. west coast. They are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (6) is less than the 105 dolphins allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

Sighting records of Risso's dolphins appear to have increased during the last two decades in some areas off the U.S. West coast.

The reproductive biology of this species is not well known. Risso's dolphins feed at night on fish, octopus and squid, but they concentrate on squid. They are usually observed in groups of 10-40 animals and may form loose aggregations of 100-200 animals (Reeves *et al.* 2002). It has been speculated that changes in ecological conditions and an El Niño event off southern California may have resulted in this species filling a niche previously occupied by pilot whales (Reeves *et al.* 2002).

There have been no recent Risso's dolphin moralities in west coast groundfish fisheries (Carretta *et al.* 2001), although Reeves *et al.*(2002) report that Risso's are a bycatch in some longline and trawl fisheries.

Short-beaked common dolphins have not been listed under the ESA or MMPA.

B.3.2.13 Short-beaked Common Dolphin *(Delphinus delphis)*

commonly inhabit tropical and warm temperate oceans. Their distribution along the U.S. west coast extends from southern California to Chile and westward to 135° West longitude (Reeves *et al.* 2002). "The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the three ship surveys is 373,573 short-beaked common dolphins"(Barlow 1997; Carretta *et al.* 2001). They are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (79) is less than the 3,188 dolphins allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

Mortalities of common dolphins may occur in set gillnets in California and in some trawl fisheries.

Reproductive activity is non-seasonal in tropical waters with peaked calving in spring and summer in more temperate waters (Reeves *et al.* 2002). Short-beaked common dolphins feed nearshore on squid, octopus and schooling fish like anchovies, hake, lantern fish, deep-sea smelt or herring. These dolphins are often seen in very large schools of hundreds or thousands and are active bow riders.

Common dolphin mortality has been estimated for set gillnets in California (Julian and Beeson 1998); however, the two species (short-beaked and long-beaked) were not reported separately. Reeves *et al*.(2002) relate that short-beaked common dolphins are also a bycatch in some trawl fisheries.

Long-beaked common dolphins have not been listed under the ESA or MMPA.

B.3.2.14 Long-beaked Common Dolphin

(Delphinus capensis) were recognized as a distinct species in 1994 (Heyning and Perrin 1994; Rosel *et al.* 1995). Their distribution overlaps with the short-beaked common dolphin, although they are more typically observed in nearshore waters. "The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the three ship surveys is 32,239 long-beaked common dolphins" (Barlow 1997; Carretta *et al.* 2001). They are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (14) is less than the 250 dolphins allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

Mortalities of common dolphins may occur in set gillnets in California and in some trawl fisheries.

Reproductive activity is similar to short-beaked: non-seasonal in tropical waters with peaked calving in spring and summer in more temperate waters (Reeves *et al.* 2002). Long-beaked common dolphins feed nearshore on squid, octopus and schooling fish like anchovies or herring. They are also active bow riders and break the water surface frequently when swimming in groups averaging 200 animals..

Common dolphin mortality has been estimated for set gillnets in California (Julian and Beeson 1998); however, the two species (short-beaked and long-beaked) were not reported separately. Reeves *et al*.(2002) relate that long-beaked common dolphins are also a bycatch in some trawl fisheries.

Short-finned pilot whales are not endangered or threatened under the ESA nor depleted under the MMPA.

B.3.2.15 Short-finned Pilot Whale

***(Globicephala macrorhynchus*)** favor a tropical and warm temperate distribution and are considered abundant (Reeves *et al.* 2002). They were common to Southern California, especially the isthmus of Santa Catalina Island during the winter (Dohl *et al.* 1980). However, following the 1982-83 El Niño they have been rarely observed (Barlow 1997). "The 1991-96 weighted average abundance estimate for California, Oregon and

Washington waters based on three ship surveys is 970 short-finned pilot whales" (Barlow 1997; Carretta *et al.* 2001). They are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (3) is less than the 6 short-finned pilot whales allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

They form social groups of 15- 50 individuals often traveling in long lines two to three animals wide. A typical sex ratio is one mature male to eight mature females; mating occurs in August through January with a 15 month gestation period (Reeves *et al.* 2002).

Short-finned pilot whales feed somewhat exclusively on market squid, *Loligo opalescens,* and were believed by fishermen to significantly compete with squid purse seine operations off Southern California. There were many records and observations of short-finned pilot whale shootings by fishermen (Heyning *et al.* 1994; Miller *et al.* 1983). Although the squid fishery has become the largest fishery in California since 1992 (Vojkovich 1998) coinciding with reduced short-finned pilot whales numbers, there have been no recent reports of mortalities in this fishery (Carretta *et al.* 2001).

Gray whales are no longer listed under the ESA or MMPA.

B.3.2.16 Gray Whale *(Eschrichtius robustus*) is represented as the Eastern Pacific stock along the west coast of North America. Currently, the population is estimated at about 26,000 whales (Reeves *et al.* 2002) with rates of increase just above two per cent (Angliss and Lodge 2002). They are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (48) is less than the 432 gray whales allowed under the Potential Biological Removal formula (Angliss and Lodge 2002).

Gray whales breed as they migrate through warmer waters; gestation lasts 12-13 months with females calving every 2-3 years (Reeves *et al.* 2002). At 5,000 miles, their migration from summer feeding grounds in the waters of Alaska to calving areas in bays and estuaries of Baja California, Mexico is one of the longest for any mammal. The Eastern North Pacific stock feeds by filtering from the bottom sediments small, bottom-dwelling amphipods, crustaceans, and polychaete worms off Alaska during summer months (Rice and Wolman 1971).

The Eastern Pacific gray whale stock was removed from the ESA List of Endangered and Threatened Wildlife in 1994. They have been an incidental catch in set net fisheries, but there have been no recent takes in groundfish fisheries (Angliss and Lodge 2002).

Minke whales are not listed under the ESA or MMPA.

B.3.2.17 Minke Whale *(Balaenoptera acutorostrata*) are one of the most widely distributed of baleen whales, ranging from South America to Alaska. For management, NMFS recognizes a California , Oregon, and Washington stock within the EEZ. "The number of minke whales is estimated as 631 (CV = 0.45) based on ship surveys in 1991, 1993, and 1996 off California and in 1996 off Oregon and Washington" (Barlow 1997; Carretta *et al.* 2001). They are not endangered or threatened under the ESA nor depleted under the MMPA. The stock is not listed as strategic under the MMPA and total human-caused mortality (0) is less than the 4 minke whales allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

Little is know of their reproductive biology, presumably they calve in winter in tropical waters after about a ten-month gestation (Reeves *et al.* 2002). They are the smallest of the rorqual whales and only the pygmy right whale is smaller. Some migrate as far north as the ice edge in summer. The diet of Minke whales consists of plankton, krill, small fish including schools of sardines, anchovies and herring.

They have occasionally been caught in coastal gillnets off California (Hanan *et al.* 1993), in salmon drift gillnet in Puget Sound, Washington, and in drift gillnets off California and Oregon (Carretta *et al.* 2001). There have been no recent takes in groundfish fisheries off California , Oregon, or Washington (Carretta *et al.* 2001).

Sperm whales are listed as endangered under the ESA.

B.3.2.18 Sperm Whale *(Physeter macrocephalus*) occur throughout the oceans and seas of the world near canyons and the continental slope. They are observed along the coasts of Oregon, and Washington (Carretta *et al.* 2001; Dohl *et al.* 1983). "Recently, a combined visual and acoustic line-transect survey conducted in the eastern temperate North Pacific in spring 1997 resulted in estimates of 24,000 (CV=0.46) sperm whales based on visual sightings, and 39,200 (CV=0.60) based acoustic detections and visual group size estimates" (Carretta *et al.* 2001). Sperm whales are ESA listed as endangered, therefore this stock is automatically considered as depleted and strategic under the MMPA. Annual human-caused mortality (1.7 whales) is less than the 2.1 sperm whales allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

Mating centers on spring, calving interval is a minimum of four to six years, and a gestation period of 18 months results in extremely low population growth rates (Reeves *et al.* 2002). All age classes and both sexes move throughout tropical waters while males range farther and farther from the equator. Sperm whales feed near the ocean bottom, diving as deep as one mile to eat large squid (including giant squid), octopuses, rays, sharks, and fish (Reeves *et al.* 2002).

There are no recent observations of sperm whale incidental catches in west coast groundfish fisheries.

Humpback whales are listed as endangered under the ESA.

B.3.2.19 Humpback Whale *(Megaptera novaeangliae)* have a world wide distribution and along Washington, Oregon, and California. NMFS recognizes the eastern North Pacific stock which is observed frequently along coastal areas. "The North Pacific total now almost certainly exceeds 6,000 humpback whales" (Calambokidis *et al.* 1997; Carretta *et al.* 2001). Humpback whales are ESA listed as endangered, therefore this stock is automatically considered as depleted and strategic under the MMPA. Annual human-caused mortality (>0.2 whales) is less than the 1.9 whales allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

One of the most famous breeding behaviors of all the marine mammals is the songs of male humpback whales. They breed during winter with a two to three year gestation and calving in the tropics (Reeves *et al.* 2002). Their migrations can be as long as 5,000 miles (one way) from the higher latitude feeding grounds to the tropics for breeding and calving. They feed on krill and pelagic schooling fish.

There are no recent observations of humpback whale incidental catches in west coast groundfish fisheries.

Blue whales are listed as endangered under the ESA.

B.3.2.20 Blue Whale *(Balaenoptera musculus)* is the largest animal ever to exist on this planet. They inhabit most oceans and seas of the world. The eastern north Pacific stock summers off California to feed and migrates as far south as the Costa Rica Dome. "The best estimate of blue whale abundance is the average of the line transect and mark-recapture estimates, weighted by their variances, or 1,940" (Carretta *et al.* 2001) whales in this stock. Blue whales are ESA listed as endangered, therefore this stock is automatically considered as depleted and strategic under the MMPA. Annual human-caused mortality (0 whales) is less than the 1.7 whales allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

Blue whale mating is unknown but calving takes place in winter after an eleven-month gestation. Calving interval is about two to three years. They feed on krill and possibly pelagic crabs (Reeves *et al.* 2002).

There are no recent observations of blue whale incidental catches in west coast groundfish fisheries.

Fin whales are listed as endangered under the ESA.

B.3.2.21 Fin Whale *(Balaenoptera physalus)* occur in the major oceans of the world and tend to be more prominent in temperate and polar waters. The California, Oregon, and Washington Stock was estimated at 1,851 fin whales based on ship surveys in summer/autumn of 1993 and 1996 (Barlow and Taylor 2001). Fin whales are ESA listed as endangered, therefore this stock is automatically considered as depleted and strategic under the MMPA. Annual human-caused mortality (1.5 whales) is less than the 3.2 whales allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

Little is known of their reproductive behavior, breeding, or calving areas. Females calving cycle is two to three years with an eleven or twelve-month gestation period following winter breeding. They probably don't make large scale migrations and feed on krill and small pelagic fish such as herring (Reeves *et al.* 2002).

There are no recent observations of fin whale incidental catches in west coast groundfish fisheries.

B.3.2.22 Killer Whale *(Orcinus orca*) inhabit most oceans and seas without respect to water temperature or depth but are more prevalent in the higher colder latitudes (Reeves *et al.* 2002). Off Washington, Oregon, and California three stocks are recognized based on behavior, photographic identification, and genetics differences. Those stocks are: Eastern North Pacific Offshore Stock, Eastern North Pacific Transient Stock, and Eastern North Pacific Southern Transient Stock (Carretta *et al.* 2001). "Based on summer/fall shipboard line-transect surveys in 1991, 1993 and 1996 (Barlow 1997), the total number of killer whales within 300 nm of the coasts of California, Oregon and Washington was recently estimated to be 819 animals. There is currently no way to reliably distinguish the different stocks of killer whales from sightings at sea..." (Carretta *et al.* 2001).

Killer whales are not listed as endangered or threatened under the ESA nor depleted under the MMPA. None of the three stocks is listed as strategic under the MMPA and total human-caused mortality is less than that allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

However, a coalition of environmental groups recently filed a petition to protect the southern population of resident killer whales under the ESA. (This population lives in both U.S. and Canadian waters.) In June 2002, NMFS ruled this population of killer whales does not merit protection under the ESA. NMFS said the stock met two criteria – that it was a separate group and that it was in danger of extinction. But the third criteria – that of being a "significant" group – was not met because the southern population is considered part of the general killer whale population in the North Pacific, which is considered healthy. NMFS favors "depleted" status, with some protections under the MMPA. In December 2002, environmental groups filed a lawsuit on agency's ruling.

Killer whales give birth in all months with the peak in calving during winter. Movement seems to track prey items; along the U.S. west coast, movements from Southeast Alaska to central California are documented (Goley and Straley 1994). Resident killer whales feed on fish including salmon, and other large bodied fish; transient killer whales feed on other marine mammals including sea otters, seals, porpoise, and baleen whales (Baird 2000); and offshore killer whales probably feed on squid and fish.

The only incidental take recorded by groundfish fishery observers was in the Bering Sea/Aleutian Islands (BSAI) groundfish trawl (Carretta *et al.* 2001). There are also reports of interactions between killer whales and longline vessels (Perez and Loughlin 1991). (Longline fishers in the Aleutian Islands reported several cases where orcas removed sablefish from longlines as the gear was retrieved.) There are no other reports of killer whale takes in west coast groundfish fisheries (Carretta *et al.* 2001).

Sei whales in the eastern North Pacific are listed as endangered under the ESA.

B.3.2.23 Sei Whale *(Balaenoptera borealis)* occur in subtropical and tropical waters into the higher latitudes and occupy oceanic, as well as, coastal waters. "Seis are known worldwide for their unpredictable occurrences, with a sudden influx into an area followed by disappearance and subsequent absence for years or even decades" (Reeves *et al.* 2002). They are rare off Washington, Oregon, and California and there are no estimates of abundance or population trends for this stock. Sei whales in the eastern North Pacific (east of longitude 180°) are considered a separate stock and listed as endangered under the ESA. Consequently, the eastern North Pacific stock is automatically considered as a depleted and strategic stock under the MMPA.(Carretta *et al.* 2001).

Sei whales usually travel alone or in small groups and little is known of their behavior. They breed and calve in winter after a 11-12 month gestation. They forage on small fish, squid, krill, and copepods.

There are no observations of sei whale incidental catches in west coast fisheries, therefore no estimated groundfish fishery related losses.

B.3.2.24 Common Bottlenose Dolphin *(Tursiops truncatus)* are distributed worldwide in tropical and warm-temperate waters. For the MMPA stock assessment reports, bottlenose dolphins within the Pacific U.S. EEZ are divided into three stocks: 1) California coastal stock, 2) California, Oregon and Washington offshore stock, and 3) Hawaiian stock.

Coastal bottlenose dolphins are not listed under the ESA or MMPA.

<u>California coastal bottlenose dolphins</u> are found within about one kilometer of shore, primarily from Point Conception south into Mexican waters. El Niño events appear to influence the distribution of animals along the California coast; since the 1982-83 El Niño they have been consistently sighted in central California as far north as San Francisco. Studies have documented north-south movements of coastal bottlenose dolphins (Hansen 1990; Defray *et al*. 1999) . Coastal bottlenose dolphins spend an unknown amount of time in Mexican waters, where they are subject to mortality in Mexican fisheries. The best estimate of the average number of coastal bottlenose dolphins in U.S. waters is 169, based on two surveys conducted in 1994 and 1999 that covered virtually the entire U.S. range of this species. The minimum population size estimate for U.S. waters is 154 coastal bottlenose dolphins. The PBR level for this stock is 1.5 coastal bottlenose dolphins per year (the minimum population size times one half the default maximum net growth rate for cetaceans (half of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997)).

Due to its exclusive use of coastal habitats, this bottlenose dolphin population is susceptible to fishery-related mortality in coastal set net fisheries. However, from 1991-94 observers saw no bottlenose dolphins taken in this fishery, and in 1994 the state of California banned coastal set gillnet fishing within 3 nm of the southern California coast. In central California, set gillnets have been restricted to waters deeper than 30 fathoms (56m) since 1991 in all areas except between Point Sal and Point Arguello. These closures greatly reduced the potential for mortality of coastal bottlenose dolphins in the California set gillnet fishery. Coastal gillnet fisheries are still conducted in Mexico and probably take animals from this population, but no details are available.

Coastal bottlenose dolphins are not listed as threatened or endangered under the ESA nor as depleted under the MMPA. Because no recent fishery takes have been documented, coastal bottlenose dolphins are not classified as a strategic stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

Offshore bottlenose dolphins are not listed under the ESA or MMPA.

California/Oregon/Washington Offshore Stock: On surveys conducted off California, offshore bottlenose dolphins have been found at distances greater than a few kilometers from the mainland and throughout the Southern California Bight. They have also been documented in offshore waters as far north as about 41°N latitude, and they may range into Oregon and Washington waters during warm water periods. Sighting records off California and Baja California (Lee 1993; Mangels and Gerrodette 1994) suggest that offshore bottlenose dolphins have a continuous distribution in these two regions. The most comprehensive multi-year average abundance for California, Oregon and Washington waters, based on the 1991-96 ship surveys, is 956 offshore bottlenose dolphins (Barlow 1997). The minimum population size estimate of offshore bottlenose dolphins is 850. The PBR level for this stock is 8.5 offshore bottlenose dolphins per year.

In 1997, a Take Reduction Plan for the California drift gillnet (non-groundfish) fishery was implemented, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders. Overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 1999). Based on 1997-98 data, the estimate of offshore bottlenose dolphins taken annually in the U.S. fishery is zero. Drift gillnet fisheries for swordfish and sharks are also conducted along the entire Pacific coast of Baja California and may take animals from the same population.

Offshore bottlenose dolphins are not listed as threatened or endangered under the ESA nor as depleted under the MMPA. Because no recent fishery takes have been documented, offshore bottlenose dolphins are not classified as a strategic stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

Striped dolphins are not listed under the ESA or MMPA.

B.3.2.25 Striped Dolphin *(Stenella coeruleoalba)* are distributed world-wide in tropical and warm-temperate pelagic waters. For the MMPA stock assessment reports, striped dolphins within the Pacific U.S. EEZ are divided into two discrete, noncontiguous areas: 1) waters off California, Oregon and Washington and 2) waters around Hawaii.

California/Oregon/Washington Stock: On recent shipboard surveys extending about 300 nmi offshore of California, striped dolphins were sighted within about 100-300 nmi from the coast. No sightings have been reported for Oregon and Washington waters, but striped dolphins have stranded in both states (Oregon Department of Fish and Wildlife, unpublished data; Washington Department of Fish and Wildlife, unpublished data). Striped dolphins are also commonly found in the central North Pacific, but sampling between this region and California has been insufficient to determine whether the distribution is continuous. Based on sighting records off California and Mexico, striped dolphins appear to have a continuous distribution in offshore waters of these two regions (Perrin *et al*. 1985; Mangels and Gerrodette 1994).

The abundance estimate for California, Oregon and Washington waters is 20,235 striped dolphins (Barlow 1997). The minimum population size estimate is 17,995. The PBR level for this stock is 180 striped dolphins per year, calculated as the minimum population size (17,995) times one half the default maximum net growth rate for cetaceans (half of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997).

Drift gillnet fisheries for swordfish and sharks conducted along the Pacific coast of Baja California may take animals from this population.

Striped dolphins are not listed as threatened or endangered under the ESA nor as depleted under the MMPA. Including U.S. driftnet information only for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 1994-98 is zero. Because recent mortality is zero, striped dolphins are not classified as a strategic stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

B.3.3 Sea Turtles

Numerous human-induced factors have adversely affected sea turtle populations in the North Pacific and resulted in their threatened or endangered status (Eckert 1993; Wetherall *et al.* 1993). Documented incidental capture and mortality by purse seines, gillnets, trawls, longline fisheries, and other types of fishing gear adversely affect sea turtles, however the relative effect of each of these sources of impact on sea turtles is difficult to assess (NMFS and USFWS 1998a; 1998b; 1998c; 1998d). Each of the sea turtle species that might interact with groundfish fisheries are listed. Little data are available estimating total annual mortalities except in the drift gillnet fishery which is not part of the groundfish FMP.

B.3.3.1 Loggerhead Sea Turtle (*Caretta caretta)*

are a widespread species inhabiting shallower continental areas in the subtropical and temperate waters (Eckert 1993; MMS 1992). Population estimates are about 300,000 loggerheads (NMFS and USFWS 1998c; Pitman 1990) and with peak abundance summer and fall off southern California (NMFS and USFWS 1998c). Throughout its range, the loggerhead turtle is listed as a threatened species under the ESA.

Juvenile and subadult loggerheads are omnivorous, foraging on pelagic crabs, molluscs, jellyfish, and vegetation captured at or near the surface. The maximum recorded diving depth for loggerhead is 233 meters (Eckert 1993).

The primary fishery threats to the loggerheads in the Pacific are longline and gillnet fisheries (NMFS and USFWS 1998c).

The green sea turtle was listed as endangered/ threatened on July 28, 1978.

B.3.3.2 Green Sea Turtle *(Chelonia mydas)* are a

cosmopolitan, highly migratory species, nesting mainly in tropical and subtropical regions. Green turtles have declining throughout the Pacific Ocean, probably due to overexploitation and habitat loss (Eckert 1993) and are listed as threatened, except for breeding populations found in Florida and the Pacific coast of Mexico listed as endangered.

The maximum recorded dive depth for an adult green turtle was 110 meters, while subadults routinely dive 20 meters for 9-23 minutes, with a maximum recorded dive of 66 minutes (Eckert 1993). Additionally, it is presumed that drift lines or surface current convergences are preferential zones due to increased densities of likely food items.

The primary green turtle nesting grounds in the eastern Pacific are located in Michoacán, Mexico, and the Galapagos Islands, Ecuador. More than 165,000 turtles were harvested from 1965 to 1977 in the Mexican Pacific. The nesting population at the two main nesting beaches in Michoacán decreased from 5,585 females in 1982 to 940 in 1984 (NMFS and USFWS 1998a).

The leatherback is the largest living turtle.

B.3.3.3 Leatherback Sea Turtle *(Dermochelys coriacea)*

coriacea) are distributed in most open ocean waters and range into higher latitudes than other sea turtles, as far north as Alaska (NMFS and USFWS 1998b), possibly associated with El Niño events. Leatherbacks were commonly sighted near Monterey Bay, mainly in August (Starbird *et al.* 1993). The leatherback turtle is listed as an endangered species under the ESA throughout its range.

Leatherbacks are the largest of the sea turtles possibly due to their ability to maintain warmer body temperature over longer time periods and distribution of prey: jellyfish, siphonophores, and tunicates (Eckert 1993). Leatherbacks are reported diving to depths exceeding 1000 meters (Lutz and Musick 1997).

Primary threats to leatherbacks in the Pacific are the killing of nesting females and eggs at the nesting beaches and the incidental take in coastal and high seas fisheries (NMFS and USFWS 1998b).

This population continues to be threatened by nearshore trawl fisheries.

B.3.3.4 Olive Ridley Sea turtle *(Lepidochelys olivacea)*

olivacea) are the most abundant sea turtle in the Pacific basin. However, although these turtles remain relatively widespread and abundant, most nest sites support only small or moderate-scale nesting, and most populations are known or thought to be depleted. The olive ridley populations on the Pacific coast of Mexico are listed as endangered; all other populations are listed as threatened.

This sea turtle species appears to forage throughout the eastern tropical Pacific Ocean, often in large groups, or flotillas. Occasionally they are found entangled in scraps of net or other floating debris. Despite its abundance, there are surprisingly few data relating to the feeding habits of the olive ridley. However, those reports that do exist suggest that the diet in the western Atlantic and eastern Pacific includes crabs, shrimp, rock lobsters, jellyfish, and tunicates. In some parts of the world, it has been reported that the principal food is algae. Although they are generally thought to be surface feeders, olive ridleys have been caught in trawls at depths of 80-110 meters (NMFS and USFWS 1998d).

B.3.4 Seabirds

Seabird species accounts are primarily taken from the online resource NatureServe, jointly established by the Nature Conservancy and the Natural Heritage Network in July 1999 to advance the application of biodiversity information to conservation, unless otherwise noted (NatureServe Explorer 2002).

The highly productive California Current System, an eastern boundary current that stretches from Baja Mexico to southern British Columbia, supports more than two million breeding seabirds and at least twice that number of migrant visitors. Over 100 species have been recorded within the EEZ including: albatross, shearwaters, petrels, storm-petrels, cormorants, pelicans, gulls, terns, and alcids (murres, murrelets, guillemots, auklets, and puffins). In addition to these "classic" seabird species, millions of other birds are seasonally abundant in this oceanic habitat including: waterfowl, waterbirds (loons and grebes), and shorebirds (phalaropes)(Tyler *et al.* 1993). Not surprisingly, there is considerable overlap of fishing areas and areas of high bird density in this highly productive upwelling system.

The species composition and abundance of birds varies spatially and temporally. The highest seabird biomass is found over the continental shelf and bird density is highest during the spring and fall when local breeding species and migrants predominate. Sooty shearwaters are the most numerous species during summer. During the winter, local breeding species and migrants from inland breeding areas, such as California gulls, predominate. In addition to local breeders and nonbreeding migrants, the rich waters of the California Current System also attract breeders from distant locations (Tyler *et al.*1993). Radio telemetry data from black-footed albatross breeding in the Hawaiian Islands document that breeding birds feeding chicks undertake long distance foraging trips to the waters off Washington, Oregon and

California to feed before returning to Hawaii to feed their chicks (Fernandez *et al.* 2001).

The U.S. Fish and Wildlife Service (USFWS) is the primary federal agency responsible for seabird conservation and management. Under the Magnuson-Stevens Act, NMFS is required to ensure that fishery management actions comply with other laws designed to protect seabirds. NMFS is also required to consult with FWS if fishery management plan actions may affect seabird species that are listed as endangered or threatened.

The short-tailed albatross was listed as endangered under the ESA in July 2000.

B.3.4.1 Albatross range extensively throughout waters off the Pacific Coast. In particular, three albatross species, the short-tailed albatross (*Phoebastria albatrus*), the black-footed albatross (*Phoebastria nigripes*), and the Laysan albatross (*Phoebastria immutabilis*) occur in the waters off Washington, Oregon, and California.

Once considered the most common albatross ranging over the continental shelf, the short-tailed albatross was hunted to near extinction in the early 1900s and is now thought to be one of the rarest birds in the world.

Sought after for its feathers and eggs, the short-tailed albatross population was decimated by hunting in the early 1900s.

Short-tailed albatross range widely in the North Pacific, breeding occurs off Japan and sightings extend from the Aleutian Islands to southern California (West Coast Groundfish Observer Program, NMFS, unpublished data, 2002). There are two known short-tailed albatross breeding colonies, one on Torishima Island and one on Minami-kojima Island, in the waters off Japan. Historical records indicate that there were over 100,000 individuals at the Torishima Island colony at the turn of the century and during 1998 - 1999 just over 400 breeding adults were found at the colony. The population on Torishima Island is now growing at an annual rate of 7.8%. The current estimate of the short-tailed albatross world population is ~1700 individuals (Hasegawa 2002; START 2002).

The short-tailed albatross population is increasing, but still vulnerable because of low numbers and low reproductive potential.

The short-tailed albatross feeds at the water's surface on squid, crustaceans, and various fish species. They sometimes follow fishing vessels and feed on offal. Chicks are fed a mixture of stomach oil and partially digested food that is regurgitated; nestlings are often fed squid, flying fishes, and crustaceans. Threats to short-tailed albatross include volcanic eruptions on the primary nesting island, Torishima, incidental take in commercial fisheries, ingestion of plastic, and the potential threat of oil spills.

Much like the short-tailed albatross, the black-footed albatross ranges throughout the North Pacific. Breeding occurs on northwestern Hawaiian Islands and Torishima Island and the species disperses from the Bering Sea south along the Pacific Coast to California.

Black-footed albatross mortality due to interactions with US-based longline fisheries is estimated to be at least 3,000 individuals per year.

Black-footed albatross is the most numerous albatross species along the Pacific Coast and is present throughout the year (Briggs *et al.* 1987). The global black-footed albatross population is estimated at about 56,500 breeding pairs and thought to be decreasing (Naughton 2003). This species is classified as vulnerable by the IUCN (International Union for the Conservation of Nature and Natural Resources) based on a 19% population decrease during 1995 - 2000 and a projected future decline of more than 20% over the next 60 years owing to interactions with longline fisheries for tuna, billfish, and groundfish in the North Pacific (Birdlife International 2001).

Black-footed albatross fed on fish, sea urchins, amphipods, and squid; foraging is done at night and prey is caught at the ocean's surface. This species will also follow fishing vessels and feed on discard. Besides interactions with longline fisheries, other threats to black-footed albatross include nest loss due to waves, pollution, introduced predators, oiling, ingestion of plastic, and volcanic eruptions on Torishima (Birdlife International 2001).

The most abundant North Pacific albatross species is the Laysan albatross. The vast majority of the Laysan albatross population breeds on the northwestern Hawaiian Islands, fewer numbers breed on the Japanese Ogasawara Islands, and still fewer pairs breed on islands off Baja California, Mexico (Guadalupe Island, Alijos Rocks, and in the Revillagigedo Islands). When at sea, the Laysan albatross ranges from the Bering Sea, to California, to Japan.

An estimated 2,000 Laysan albatross were killed each year between 1996 - 1998 in longline fisheries around Hawaii.

The USFWS counts this species at Midway Atoll once every four years and counts or samples density at French Frigate Shoals and Laysan Island every year. These monitoring sites account for 93% of the world population of ~393,000 breeding pairs. At the three sites listed above breeding populations have declined at an average rate of 3.2% per year since 1992. This represents a 32% decline in annual breeding attempts over a 10-year period (Naughton 2003).

Similar to the other North Pacific albatross species, Laysan albatross feed on schooling fish and squid at the ocean's surface and the primary threat to their population is interactions with fisheries.

> The California brown pelican was listed as endangered under the ESA in 1970.

> Brown pelican nesting habitats are especially sensitive to human disturbance.

B.3.4.2 California brown pelican *(Pelecanus occidentalis californicus)* range along the Pacific Coast from British Columbia south to central America. Historically, breeding colonies were found at Point Lobos, California and from the Channel Islands south to Baja California, Mexico. They are found in coastal areas, on rocky shores and cliffs, in sloughs, and may also be found on breakwaters, jetties, pilings, and sandbars in harbors. While the California brown pelican still occurs throughout its original range, the breeding colonies in California, located in the Channel Islands National Park, West Anacapa Island, and the Santa Barbara Islands, are in decline (CDFG 2000).
In the 1970s, California brown pelicans were threatened with extinction by the widespread use of the pesticide DDT (dichlorodiphenyltrichloroethane). This chemical is transmitted via the food chain and becomes concentrated in top predators. DDT affects the pelican's ability to metabolize calcium, resulting in thin-shelled eggs that break during incubation. The use of DDT was banned in 1972 and the California brown pelican population subsequently began its recovery (CDFG 2000).

In the early 2000s, it was estimated that the brown pelican breeding population in California was about 9,000 adults (CDFG 2001). While the brown pelican population is thought stable, food availability is a cause for concern. Pacific mackerel, Pacific sardine, and the northern anchovy are important prey for brown pelicans, especially during the breeding season. However, commercial over-harvesting of these coastal pelagic species has reduced the quantity of prey that is available to pelicans (CDFG 2000).

The primary threats to California brown pelicans are human development in coastal regions, entanglement in abandon recreational fishing gear, and oil spills (CDFG 2000).

> The California least tern was listed as endangered under the ESA in June 1970.

> In 2002, the gull-billed tern, elegant tern, Caspian tern, and arctic tern were considered "birds of conservation concern" by the USFWS.

B.3.4.3 Terns - Nine species of terns occur along the Pacific coast, they are the arctic tern (*Sterna paradisaea*), common tern (*Sterna hirundo*), black tern (*Chlidonias niger*), California least tern (*Sterna antillarum browni*), Caspian tern (*Sterna caspia*), Forster's tern (*Sterna forsteri*), gull-billed tern (*Sterna nilotica*), royal tern (*Sterna maxima*), and elegant tern (*Sterna elegans*).

The populations of most tern species found along the Pacific Coast are stable, however, some tern species are listed under the

ESA or are considered "birds of conservation concern" by the USFWS.

The range of the California least tern is limited to California and Baja California. During 1988 - 1989 in California, the population was estimated to be about 1,250 pairs. As with most species of terns, California least tern are found along seacoasts, beaches, bays, estuaries, lagoons, lakes, and rivers. Terns usually nest on open, flat beaches along lagoons or estuary margins. California least terns usually nest in the same area during successive years and tend to return to the natal site to nest.

Terns obtain their prey by diving from the air into shallow water and their diet is predominately small fishes (e.g., anchovy, surf-perch).

Primary threats to the California least tern population and possible threats to other tern populations, include human development of nesting habitat and predation of adults, eggs, and young by birds and introduced mammals.

B.3.4.4 Murrelets - Four species of murrelets occur along the Pacific coast, they are the marbled murrelet (*Brachyramphus marmoratus*), Craveri's murrelet (*Synthliboramphus craveri*), Xantus's murrelet (*Synthliboramphus hypoleucus*), and the ancient murrelet (*Synthliboramphus antiquus*).

The marbled murrelet was listed as threatened under the ESA in October 1992 .

The marbled murrelet has an extensive range along the Pacific Coast, extending from Alaska to California and breeding occurs throughout their range. These birds are found in coastal areas, mainly in salt water, often in bays and sounds. They are also found up to 5 km offshore and are occasionally sighted on lakes and rivers within 20 km of the coast. Most populations are dependent upon large coniferous trees in old-growth forests as suitable nesting habitat.

In the Pacific Northwest, approximately 90% - 95% of old-growth, marbled murrelet habitat has been removed by large-scale logging since the mid-1800s.

The marbled murrelet population has probably declined substantially throughout the region and it is estimated that 10,000 - 20,000 individuals remain(Carter *et al.* 1995).

The diet of marbled murrelets includes fishes (e.g., sandlance, capelin, herring), crustaceans, and mollusks. Birds may also feed exclusively on freshwater prey for several weeks. Marbled murrelets typically forage in waters up to 80 m in depth and 2 km from shore. Birds dive to capture prey; dives may extend down 30 m below the water's surface.

The continued harvest of old-growth and mature coastal coniferous forest threatens critical nesting habitat throughout the marbled murrelet range. Additional threats to this population are interactions with gillnet fisheries and oil spills.

The ancient murrelet ranges along the Pacific Coast from Alaska to California. The estimated global population is on the order of half a million breeding pairs, with just over half found on the Queen Charlotte Islands of British Columbia. This species nests in rocky offshore islands in crevices, under rocks, at the base of trees, and in burrows. Declines in the ancient murrelet population are often attributed to the introduction of predators onto offshore islands used for breeding. Rats, raccoons, and foxes have reduced what was once the world's the largest colony (Langara Island, British Columbia) from about 200,000 pairs in 1969 to 15,000 pairs in 1994. Ancient murrelets are also threatened by food availability, which is subject to pesticide pollution, and changes in marine currents controlling local productivity.

> In 2002, the Pacific Seabird Group submitted federal and state petitions to list the Xantus's murrelet as threatened under the ESA. Additionally, this species is considered a "bird of conservation concern" by the USFWS.

Xantus's and Craveri's murrelets have relatively restricted ranges, when compared to other Pacific Coast murrelets, and are primarily found in California. Both species breed on islands; the Craveri's breeds in the Gulf of California and along the western coast of Baja California while the Xantus's breeds on islands off central California and western Baja California.

> Both the Craveri's and Xantus's murrelets are classified as vulnerable by the IUCN.

The population of the Craveri's murrelets is estimated to be between 6,000 and 10,000 individuals. Xantus's murrelets persist in very low numbers and the breeding population is estimated to be between 2,000 and 5,000 individuals. Both species are threatened by introduced predations on breeding islands, specifically rats and feral cats, and oil spills, specifically spills from offshore platforms in Santa Barbara Channel and oil tanker traffic in Los Angeles harbor (Carter *et al.* 1995).

B.3.4.5 Northern fulmars *(Fulmarus glacialis)*

range along the Pacific Coast from Alaska to Oregon and they are primarily pelagic.

> Northern fulmars exhibit a strong fidelity to their mates and nest sites, with changes to either only occurring on the order of less than 1% per year.

The estimated total population of northern fulmars in the North Pacific is between 3 and 3.5 million individuals (Hatch 1993). This species primarily breeds in Alaska at colonies on sea cliffs and, less frequently, on low, flat rocky islands. Northern fulmars show strong mate and nest site fidelity (Shallenberger 1984). Nests are often raided by weasels and gulls.

Northern fulmars are surface feeders, they swim or float upon the ocean's surface while feeding on organisms found just below the surface. The diet of this species includes fishes, mollusks, crustaceans, and cephalopods. Northern fulmars have also been observed following fishing vessels, presumably to feed on offal.

Primary threats to northern fulmars are oil pollution, plastic debris, entanglement in fishing gear, and introduced predators and human disturbance on breeding islands (Hatch 1993).

B.3.4.6 Storm-petrels - Seven species of storm-petrels occur along the Pacific Coast, they include the black storm-petrel (*Oceanodroma melania*), fork-tailed storm-petrel (*Oceanodroma furcata*), ashy storm-petrel (*Oceanodroma homochroa*), least storm-petrel (*Oceanodroma microsoma*), Galapagos storm-petrel (*Oceanodroma tethys*), Wilson's storm-petrel (*Oceanites oceanicus*), and Leach's storm-petrel (*Oceanodroma leucorhoa*).

In 2002, the ashy storm-petrel was considered a "bird of conservation concern" by the USFWS.

Populations of storm-petrel species found along the Pacific Coast, along with the amount of information known about different populations, varies considerably. In the North Pacific, Leach's storm-petrel is the most abundant species (a conservative total population estimate is between 10 and 15 million individuals) followed by the fork-tailed storm-petrel (total population estimate is between 5 and 10 million individuals). Conversely, the populations of ashy storm-petrels (total population estimated at fewer than 10,000 individuals), black storm-petrels (population estimate ranges between 10, 000 and 100,000 individuals), and least storm-petrels (population estimate ranges between 10,000 and 50,000 individuals) may be at risk (Boersma and Groom 1993).

Storm-petrel chicks are fed a regurgitated fish oil, rather than the prey items themselves, enabling adults to make longer foraging trip.

Storm-petrels are pelagic, spending the majority of their lives at sea and returning to land only to breed. When at the breeding colonies, storm-petrels are nocturnal, an adaptation that reduces their susceptibility to diurnal predators (e.g., gulls)(Speich and Wahl 1989). Nests are often located in burrows, rocky crevices, or grassy slopes on small coastal islands. Some species of storm-petrels nest in the same burrow in successive years (Spendelow and Patton 1988).

Storm-petrels have a well developed olfactory system and use their keen sense of smell to locate prey and burrow and nest sites.

Storm-petrels feed at the water's surface, rarely diving beneath the surface in pursuit of food. They catch prey by "dipping and pattering," that is they hover on outstreched wings, paddle the water with their webbed feet, and dip their bills into the water (Ainley 1984a). The diet of storm-petrels includes such things as plankton, small fishes, crustaceans, and small squid.

Primary threats to storm-petrels include introduced predators on breeding islands, pesticides and contaminants, pollution, and oil spills.

B.3.4.7 Shearwaters - Eight species of shearwaters range along the Pacific Coast, they include Townsend's shearwater (*Puffinus auricularis*), black-vented shearwater (*Puffinus opisthomelas*), wedge-tailed shearwaters (*Puffinus pacificus*), sooty shearwater (*Puffinus griseus*), short-tailed shearwater (*Puffinus tenuirostris*), pink-footed shearwater (*Puffinus creatopus*), flesh-footed shearwater (*Puffinus carneipes*), and Buller's shearwater (*Puffinus bulleri*).

> Townsend's shearwater is classified as critically endangered by the IUCN.

The populations of most shearwater species found along the Pacific Coast are stable, however, some shearwater populations are considered at risk by the IUCN. Many species of shearwaters move between hemispheres to take advantage of the best feeding conditions (Shallenberger 1984).

> The black-vented, pink-footed, and Buller's shearwaters are classified as vulnerable by the IUCN.

The black-vented shearwater breeds on a handful of small islands off the coast of Baja California; the wedge-tailed and Townsend's shearwater breed on islands off the coasts of Mexico and Hawaii. The five remaining species of shearwater breed in the southern hemisphere on islands off the coast of Chile, Australia, and New Zealand. Much like storm-petrels, shearwaters nest in burrows and rocky crevices and their activities at breeding colonies are largely nocturnal.

When foraging, shearwaters may feed at the water's surface, plunge from just above the water's surface, or dive to depths of 50 m. Their diet includes small fishes (e.g., northern anchovies, Pacific sardines), squid, plankton, and crustaceans.

> By moving between hemispheres, many species of shearwaters live in perpetual "summer" taking advantage of the best feeding conditions.

Shearwater populations are primarily threatened by predation by feral mammals (e.g., cats, pigs, mongoose, rats) and loss of habitat on breeding islands. Other threats associated with urbanization include collisions with power lines and attraction to lights.

B.3.4.8 Cormorants - Three species of cormorants occur along the Pacific Coast: Brandt's cormorant (*Phalacrocorax penicillatus*), double-crested cormorant (*Phalacrocorax auritus*), and pelagic cormorant (*Phalacrocorax pelagius*).

> The populations of the Brandt's, the double-crested, and the pelagic cormorant are either stable or increasing along the Pacific Coast.

Brandt's cormorants are by far the most abundant cormorant species nesting along the coast of Oregon and California. In Washington, however, they have never been numerous or widespread (Spendelow and Patton 1988). Brant's cormorants are typically found in inshore, coastal areas, especially in areas having kelp beds, brackish bays, sheltered inlets, and quiet bays. Large numbers of birds breed in California and Oregon with fewer numbers breeding in Washington. Brandt's cormorant usually nests on offshore islands or, less frequently, on inaccessible mainland bluffs and wide cliff ledges near the water (Speich and Wahl 1989). Resident throughout the year near nesting areas, birds range more widely during non-breeding periods.

Because cormorant feathers are not water-proof, birds are usually found within a few hours of their roosting or breeding sites.

Double-crested cormorants are widespread and breeding populations along the Pacific Coast seem to be increasing in number (Carter *et al.* 1995; Spendelow and Patton 1988). They can be found along seacoasts, marine islands, coastal bays, swamps, lagoons, rivers, and lakes. Double-crested cormorants nest in variety of habitats. Along the coast, they nest on offshore rocks and islands, exposed dunes, abandoned wharf timbers, and power poles. Birds nesting inland often use trees or snags (Sowls *et al.* 1980; Speich and Wahl 1989). Birds are usually found within a few hours of their roosting or breeding sites (Ainley 1984b).

Breeding populations of pelagic cormorants are relatively evenly distributed from Washington to California (Spendelow and Patton 1988) and in recent years, populations have been increasing in number. Pelagic cormorants occur in outer coastal habitats, bays, and inlets, especially in rock-bottom habitats and often in water less than 100 m and within 1 - 2 km of shore. These birds will often nest with other pelagic cormorants or near other species of seabirds. Nesting occurs on island cliff ledges, crevices, and in sea caves by building nests out of seaweed (Sowls *et al.* 1980).

In California, reproductive success of cormorants was decrease by eggshell thinning due to pesticide contamination.

Cormorants are classified as diving birds, their strong swimming ability enables them to pursue and capture their prey underwater. Their diet includes small fishes, squid, crabs, marine worms, and amphipods.

Cormorant populations are threatened by pesticides, human disturbance at nesting sites, oiling, and interactions with fisheries.

B.3.4.9 Jaegers - Three species of jaegers occur along the Pacific Coast: the pomarine jaeger (*Stercorarius pomarinus*), parasitic jaeger (*Stercorarius parasiticus*), and long-tailed jaeger (*Stercorarius longicaudus*).

Jaegers are considered the birds of prey of the marine world and are commonly referred to as the "sea falcon".

All three species of jaegers are primarily pelagic, but may be found in bays and harbors. Jaegers breed in the arctic and sub-arctic. Non-breeding birds and breeders during the non-breeding season can be found off Washington, Oregon, and California.

The diet of jaegers includes small mammals, birds, bird eggs, fishes, invertebrates, and offal from fishing vessels. Jaegers are well known for their habit of pursing other seabirds on the wing (Maher 1984), forcing the other birds to disgorge their food, and then stealing the food before it hits the ground.

B.3.4.10 Gulls - Eleven species of gulls occur along the Pacific Coast, these include the glaucous gull (*Larus hyperboreus*), glaucous-winged gull (*Larus glaucescens*), western gull (*Larus accidentalis*), herring gull (*Larus argentatus*), California gull (*Larus californicus*), Thayer's gull (*Larus thayeri*), ring-billed gull (*Larus delawarensis*), mew gull (*Larus canus*), Heermann's gull (*Larus heermanni*), Bonaparte's gull (*Larus philadelphia*), and Sabine's gull (*Larus sabini*).

> The glaucous-winged gull is the most numerous and widely distributed gull in the eastern North Pacific.

> The western gull colony on Southeast Farallon Island is the largest gull colony along the Pacific Coast.

For most marine-nesting species in the North Pacific, only rough estimates of nesting populations exist and reproductive success has only been investigated for one to two years (Vermeer *et al.* 1993). However, it is thought that most gull populations along the Pacific Coast are stable and not considered to be at risk.

Most gulls along the Pacific Coast occur during the non-breeding season or are non-breeding individuals. Birds can be found at sea, along the coast, on rocky shores or cliffs, bays, estuaries, beaches, and garbage dumps. Only two species of gulls breed along the Pacific Coast. The glaucous-winged gull has breeding colonies in British Columbia and Washington and the western gull has breeding colonies in California (most are located on the Farallon Islands), Oregon, and Washington (Drury 1984). Breeding habitat for these gulls includes coastal cliffs, rocks, grassy slopes or offshore rock or sandbar islands.

Pacific Coast gulls feed at the ocean's surface and their diet typically includes fishes, mollusks, crustaceans, carrion, and garbage.

Primary threats to gulls include human disturbance at nesting locations.

> Kittiwakes, named for their shrill cries, are among the most oceanic of the gull family.

B.3.4.11 Black-legged kittiwakes *(Rissa tridactyla)* range along the Pacific Coast from Alaska to Mexico (Drury 1984). While they are primarily pelagic, black-legged kittiwakes can also be found along sea coasts, bays, and estuaries.

It is estimated that there are approximately 2.6 million black-legged kittiwakes at colonies in the North Pacific. This species breeds on mainland and island sites in the Arctic and along the Aleutian islands.

Black-legged kittiwakes feed at the ocean's surface and their diet typically includes small fishes, mollusks, crustaceans, and plankton (Hatch *et al.* 1993).

Primary threats to black-legged kittiwakes are unknown.

In the mid-1800s, over 14 million murre eggs were harvested from Southeast Farallon Island to feed residents of the San Francisco Bay area.

B.3.4.12 Common murres *(Uria aalge)* range along the Pacific Coast from Alaska to central California. While they are primarily pelagic, common murres can also be found along rocky sea coasts.

Common murres are the dominant member of the breeding seabird community along the Pacific Coast, but numbers have declined substantially in central California and Washington. In the mid-1800s, over 14 million murre eggs were harvested from Southeast Farallon Island to feed residents of the San Francisco Bay area (Manuwal 1984). The Washington population has been almost extirpated over the last decade, due to a combination of oceanographic conditions, gillnets, low-flying aircrafts, and oil spills, and has not recovered. In contrast, the population of common murres in Oregon and California has been stable or increasing despite human disturbance(Carter *et al.* 1995). In the late 1980s, the Pacific Coast population was estimated to be greater than 600,000 individuals. Nesting typically occurs in large, dense colonies on mainland and island cliff ledges or on rocky, low-lying islands. Common murres do not build nests but lay their eggs directly on the bare soil or rock (Spendelow and Patton 1988).

Common murres are diving birds, capturing their prey underwater, and can descend to depths of 180 m. Their diet includes fishes, squid, mysids, and shrimp.

Primary threats to common murres include predators on breeding islands, increasing sea surface temperature, oil spills, gill-net mortality, and military practice bombing activity.

The pigeon guillemot engages in spectacular aerial courtship chases, during which their bright orange feet and legs are prominently displayed.

B.3.4.13 Pigeon guillemots *(Cepphus columba)* range along the Pacific Coast from Alaska to southern California.

While these birds are primarily pelagic, they can be found along rocky coasts and in bays and inlets.

In the late 1980s, the pigeon guillemot breeding population along the Pacific Coast was estimated to be greater than 20,000 individuals. Breeding occurs along coasts, on islands, on cliffs, in rock crevices, in abandon burrows, or they may dig their own burrows. Pigeon guillemots have a spectacular courtship behavior (Manuwal 1984) and may use the same nest in successive years (Spendelow and Patton 1988).

Pigeon guillemots forage underwater; their diet includes small fishes, generally inshore benthic species, mollusks, crustaceans, and marine worms.

Primary threats to pigeon guillemots include introduced predators on breeding islands, inshore gillnet fisheries, and oil spills (Erwins *et al.* 1993).

B.3.4.14 Auklets - Three species of auklets occur along the Pacific Coast: the parakeet auklet (*Aethia psittacula*), the rhinoceros auklet (*Cerorhinca monocerata*), and the Cassin's auklet (*Ptychoramphus aleuticus*).

In 2002, the Cassin's auklet was considered a "bird of conservation concern" by the USFWS.

In the eastern North Pacific, the estimated population of Cassin's auklets is over 3 million and the estimated population of parakeet auklets is approximately 200,000 (Springer *et al.* 1993). The estimated breeding population of rhinoceros auklets along the Pacific Coast is just over 60,000 (Spendelow and Patton 1988).

Auklets are primarily pelagic, however, they are also found along rocky coasts. The parakeet auklet only breeds in Alaska, while the rhinorceros and Cassin's auklets breed on offshore islands between Alaska and Baja California. Nesting generally occurs in areas with low vegetation, in burrows, or under rocks. Some nesting sites are used in successive years. Auklets may be diurnal as well as nocturnal.

Auklets dive from the water's surface when foraging. Their diet generally includes small fishes, crustaceans, and squid.

Primary threats to auklets include introduced predators on nesting islands, long-term oceanographic changes in the California Current System which caused a decline in zooplankton populations, and oil spills.

In their breeding plumage of black, orange, white, and red, puffins are some of the most colorful of marine birds.

B.3.4.15 Puffins - Two species of puffins occur along the Pacific Coast, these include the horned puffin (*Fratercula corniculata*) and the tufted puffin (*Fratercula cirrhata*). These colorful puffins (Manuwal 1984) are primarily pelagic but they can also be found along the coast.

In the North Pacific, the estimated breeding population of tufted puffins and horned puffins is 3.5 million and 1.5 million, respectively (Byrd et al. 1993). Puffins breed on offshore islands or along the coast; nesting occurs in ground burrows, under and among rocks, and occasionally under dense vegetation. Horned puffins only nest in Alaska, while tufted puffins nest all along the Pacific Coast from Alaska to California.

Puffins are diving birds and capture their prey underwater. Their diet includes fish, cephalopods, crustaceans, and polychatetes.

Primary threats to puffins include introduced predators on breeding islands, oil spills, and gillnet fisheries. Low numbers of tufted puffins in California may be due to oil pollution and/or declines in the sardine population.

B.3.4.16 South polar skuas *(Stercorarius maccormicki)* range along the Pacific Coast from Alaska to Mexico. While these birds are primarily pelagic and solitary, they can sometimes be found in small, loose groupings in and around harbors.

South polar skuas breed in and around Antarctica. Non-breeders can be found spring through fall along the Pacific Coast.

> Like jaegers, south polar skuas are also considered the birds of prey of the marine world and known as the “sea hawk”.

The diet of south polar skuas is diverse (Maher 1984). At sea, they pursue foraging seabirds until the other birds relinquish their prey, as well as following fishing vessels to forage on offal. On the breeding grounds, their diet includes fish, seabirds, small mammals, krill, penguin eggs and young, and carrion.

Because south polar skuas breed in such remote locations, there are relatively few threats to the breeding population. Additionally, they are relatively immune to threats during the non-breeding season because they spend the majority of their time at sea.

B.3.4.17 Black skimmers (*Rynchops niger*) can be found in California. This species is primarily found nearshore in coastal waters including bays, estuaries, lagoons, and mudflats.

In the late 1970s - early 1980s, the estimated breeding population of black skimmers throughout the United States was about 65,000 individuals and increasing. In California, however, less than 100 breeding individuals were found (Spendelow and Patton 1988).

Nesting generally occurs near coasts on sandy beaches, shell banks, coastal and estuary islands, salt pond levees, and on dredged material sites. Black skimmers are often nesting in association with or near terns.

In 2002, the black skimmer was considered a "bird of conservation concern" by the USFWS.

As their name suggests, black skimmers forage by flying low over the water and skimming food off the surface with their lower mandible. The diet primarily includes small fish and crustaceans.

Primary threats to black skimmers include predation and human disturbance on nesting islands.

B.4 References

Adams, P., and R. M. Starr. 2001. Lingcod. Pages 191-194 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

ADFG. (Alaska Department of Fish and Game). 1994. ADF&G's Wildlife Notebook Series: Dungeness Crab. Alaska Dept. Fish and Game. Accessed: September 2002 at. www.state.ak.us/local..es/FISH.GAME/notebook/shellfish/dungie.htm.

Ainley, D. G. 1984a. Storm-petrels. Pages 58-63 *in* D. Haley, editor. Seabirds of Eastern North Pacific and Arctic Waters. Pacific Search Press, Seattle.

Ainley, D. G. 1984b. Cormorants. Pages 92-101 *in* D. Haley, editor. Seabirds of Eastern North Pacific and Arctic Waters. Pacific Search Press, Seattle.

Alderdice, D. F., and C. R. Forrester. 1971. Effects of salinity and temperature on embryonic development of Petrale sole (*Eopsetta jordani*). J. Fish. Res. Bd. Canada 28:727-744.

Allen, M. J., and G. B. Smith 1988. Atlas and zoogeography of common fishes in the Bering Sea and northeastern Pacific. NOAA, NMFS Tech. Memo. 66. 151p.

Alverson, D. L., A. T. Pruter, and L. L. Ronholt. 1964. A study of demersal fish and fisheries of the northeastern Pacific Ocean. Inst. Fish., University of British Columbia, Vancouver, B.C.. 190p.

Arora, H. L. 1951. An investigation of the California sanddab (*Citharichthys sordidus*). Calif. Dept. Fish Game 37:3-42.

Ashcraft, S. E., and M. Heisdorf. 2001. Brown rockfish. Pages 170-172 *in* W. S. Leet , C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Barlow, J. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drft gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 20p.

Barnes, J. T. 2001. Cowcod. Pages 363-365. *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Barnes, J. T., S. L. Owen, and L. D. Jacobson. 2001. Thornyheads. Pages 374-377 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Barnhart, R. A. 1988. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)--Pacific herring. U.S. Fish Wildl. Serv., 82(11.79). U.S. Army Corps of Engineers, TR EL-82-4. 14p.

Barss, W. H. 1976. The Pacific sanddab. Oregon Department of Fish and Wildlife, Newport, OR, March, 1976, Informational Report 76-5. 5p.

Barss, W. H., and T. Wyllie Echeverria. 1987. Maturity of widow rockfish *Sebastes enotmelas* from the northeastern Pacific, 1977-82. Pages 13-18 *in* W. H. Lenarz, and D. R. Gunderson, editors. Widow Rockfish, Proceedings of a Workshop, December 11-12, 1980, Tiburon, California. NOAA, NMFS Tech. Rep. 48.

Becker, D. D., and K. K. Chew. 1987. Predation on *Capitella* spp. by small-mouthed pleuronectids in Puget Sound, Washington. Fish. Bull. 85:471-479.

Bence, J. R., and J. E. Hightower. 1990. Status of bocaccio in the Conception/Monterey/Eureka INPFC areas in 1990. *In* Stock Assessment and Fishery Evaluation. Appendix to status of the Pacific Coast groundfish fishery through 1990 and recommended acceptable biological catches for 1991. Pacific Fishery Management Council, Portland, OR.

Birdlife International. 2001. BirdLife's Online World Bird Database. BirdLife International. Accessed: February 5, 2003 at www.birdlife.net.

Boersma, P. D., and M. J. Groom. 1993. Conservation of storm-petrels in the North Pacific. Pages 112-121 *in* K. Vermeer, K.T. Briggs, K.H. Morgan and D. Siegel-Causey, editors. The Status, Ecology, and Conservation of Marine Birds in the North Pacific. Can. Wildl. Serv. Spec. Publ., Ottawa.

Briggs, K. T., W. B. Tyler, D. B. Lewis, and D. R. Carlson. 1987. Seabird communities at sea off California: 1975-1983. Studies in Avian Biology 11:74p.

Buckley, T. W., G. E. Tyler, D. M. Smith, and P. A. Livingston. 1999. Food habits of some commercially important groundfish off the coasts of California, Oregon, Washington, and British Columbia. U.S. Dept. of Comm., NOAA Tech Memo. NMFS-AFSC-102. 173p.

Butler, J. L., L. D. Jacobson, and J. T. Barnes. 1998. Stock assessment for blackgill rockfish. *In* The status of the Pacific coast groundfish fishery through 1998 and recommended acceptable biological catches for 1999. Pacific Fishery Management Council, Portland, OR.

Butler, J. L., L. D. Jacobson, J. T. Barnes., H. G. Moser, and R. Collins. 1999. Stock assessment of cowcod. *In* Status of the Pacific coast groundfish fishery through 1999 and recommended acceptable biological catches for 2000 (SAFE report). Pacific Fishery Management Council, Portland, OR.

Cailliet, G. M., E. K. Osada, and M. Moser. 1988. Ecological studies of sablefish in Monterey Bay. Calif. Fish and Game, Vol. 74(3):132-153.

Carter, H. R., D. S. Gilmer, J. E. Takekawa, R. W. Lowe, and U. W. Wilson. 1995. Breeding birds in California, Oregon, and Washington. Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems U.S. Dept. of Interior, National Biological Service. Accessed: April 22, 2003 at www.biology.usgs.gov.

Castillo, G. C. 1995. Latitudinal patterns in reproductive life history traits of northeast Pacific flatfish. Pages 51-72 *in* Proceedings of the International Symposium on North Pacific Flatfish. Alaska Sea Grant College Program, AK-SG-95-04.

CDFG. (California Dept. of Fish and Game). 2000. California brown pelican. California's Threatened and Endangered Species. Calif. Dept. Fish and Game. Accessed: April 22, 2003 at www.dfg.ca.gov.

CDFG. 2001. Marine Bird Resources. Pages 541-552 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's Living Marine Resources: A Status Report. Calif. Dept. Fish and Game.

CDFG. 2002. Preliminary Draft Market Squid Fishery Management Plan. Calif. Dept. Fish and Game. Accessed: May 24, 2002 at www.dfg.ca.gov/mrd/marketsquid/msfmp.html.

Charnov, E. L., and R. W. Hannah. 2002. Shrimp adjust their sex ratio to fluctuating age distributions. Evolutionary Ecology Research 4:239-246.

Clark, W. G. 1991a. Evaluation of Pacific Halibut Management for Regulatory Area 2A. Pages 39-44 *in* II. Critique of the Area 2A Stock Assessment. International Pacific Halibut Commission, Sci. Rpt.74.

Clark, W. G., and S. Hare. 2001. Assessment of the Pacific halibut stock at the end of 2001. Pages 121-142 *in* Report of Assessment and Research Activities 2001. International Pacific Halibut Commission. Accessed: August 12, 2002 at www.iphc.washington.edu.

Clark, W. G., and G. H. Williams. 2001. History of Area 2 fisheries, management and assessments. Pages 91-102 *in* Report of Assessment and Research Activities 2001. International Pacific Halibut Commission. Accessed: August 12, 2002 at www.iphc.washington.edu.

Collier, P. C., and R. W. Hannah. 2001. Ocean Shrimp. Pages 118-120 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's Living Marine Resources: A Status Report. Calif. Dept. Fish and Game.

Cross, J. N. 1987. Demersal fishes of the upper continental slope off southern California. Calif. Coop. Oceanic Fish. Invest. Rep. 28:155-167.

Defran, R. H., D. W. Weller, D. L. Kelly, and M. A. Espinosa. 1999. Range characteristics of Pacific coast bottlenose dolphins (*Tursiops truncatus*) in the Southern California Bight. Mar. Mamm. Sci. 15:381-393.

Demory, R. L., M. J. Hosie, N. TenEyck, and B. O. Forsberg. 1976. Marine resources surveys on the continental shelf off Oregon, 1971-74. Oregon Dept. Fish and Wildlife., Newport, OR, Completion Report. 49p.

Dorn, M. W., M. W. Saunders, C. D. Wilson, M. A. Guttormsen, K. Cooke, and M. E. Wilkins. 1999. Stock assessment of coastal Pacific hake/whiting in U.S. and Canadian in 1998. *In* Appendix to Status of the Pacific Coast groundfish fishery through 1999 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Drury, W. H. 1984. Gulls. Pages 130-145 *in* D. Haley, editor. Seabirds of Eastern North Pacific and Arctic Waters. Pacific Search Press, Seattle.

Dunn, J. R., and A. C. Matarese. 1987. A review of early life history of northeast Pacific gadoid fishes. Fish. Res. 5:163-184.

Erwins, P. J., H. R. Carter, and Y. V. Shibaev. 1993. The status, distribution, and ecology of inshore fish-feeding alcids (*Cepphus* guillemots and *Brachyramphus* murrelets) in the North Pacific. Pages 164-175 *in* K. Vermeer, K.T. Briggs, K.H. Morgan and D. Siegel-Causey, editors. The Status, Ecology, and Conservation of Marine Birds in the North Pacific. Can. Wildl. Serv. Spec. Publ., Ottawa.

Eschmeyer, W. N., E. S. Herald, and H. Hammann. 1983. Field Guide to Pacific Coast Fishes of North America. Houghton Mifflin, Boston. 336p.

Fernandez, P., D. J. Anderson, P. R. Sievert, and K. P. Huyvaert. 2001. Foraging destinations of three low-latitude albatross (*Phoebastria*) species. J. of Zoology 254:391-404.

Fox, D. 2003. Oregon Dept. Fish and Wildlife. Personal Communication: J. T. Golden, Newport, OR.

Fujiwara, S., and D. G. Hankin. 1988. Sex ratio, spawning period, and size and age at maturity of sablefish, *Anoplopoma fimbria,* in northern California. Nippon Suisan Gakkaishi 54:27-31.

Gabriel, W., and W. G. Pearcy. 1981. Feeding selectivity of Dover sole, *Microstomus pacificus*, off Oregon. Fish. Bull. 79:749-763.

Garrison, K. J., and B. S. Miller 1982. Review of the early life history of Puget Sound fishes. Fish. Res. Inst., University of Washington, Seattle. Rept. No. UW 8216. 729p.

Gustafson, R. G., W. H. Lenarz, B. B. McCain, C. C. Schmitt, W. S. Grant, T. L. Builder, and R. D. Methot 2000. Status review of Pacific hake, Pacific cod, and walleye pollock from Puget Sound, Washington. NOAA Tech. Memo. NMFS-NWFSC-44. 275p.

Hannah, R. W. 1995. Variation in geographic stock area, catchability, and natural mortality of ocean shrimp (*Pandalus jordani*): some new evidence for a trophic interaction with Pacific hake (*Merluccius productus*). Can. J. Fish. Aquat. Sci. 52:1018-1029.

Hansen, L. J. 1990. California coastal bottlenose dolphins. Pages 403-420 *in* S. Leatherwood and R.R. Reeves, editors. The Bottlenose Dolphin. Academic Press, Inc., San Diego, CA.

Hart, J. L. 1973. Pacific Fishes of Canada. Bull. Fish. Res. Bd. Canada 180:730p.

Hatch, S. A. 1993. Ecology and population status of Northern Fulmars *Fulmarus glacialis* of the North Pacific. Pages 82-92 *in* K. Vermeer, K.T. Briggs, K.H. Morgan and D. Siegel-Causey, editors. The Status, Ecology, and Conservation of Marine Birds in the North Pacific. Can. Wildl. Serv. Spec. Publ., Ottawa.

Hatch, S. A., G. V. Byrd, D. B. Irons, and J. Hunt, G.L. 1993. Status and ecology of kittiwakes (*Rissa tridactyla* and *R. brevirostris*) in the North Pacific. Pages 140-153 *in* K. Vermeer, K.T. Briggs, K.H. Morgan and D. Siegel-Causey, editors. The Status, Ecology, and Conservation of Marine Birds in the North Pacific. Can. Wildl. Serv. Spec. Publ., Ottawa.

Heifetz, J., and J. T. Fujioka. 1991. Movement dynamics of tagged sablefish in the northeastern Pacific Ocean. Fish. Res.11:355-374.

Helser, T. E. 2002a. A rebuilding analysis of the West Coast Pacific whiting (hake) stock. *In* Status of the Pacific Coast Groundfish Fishery through 2002 (SAFE Report), volume I. Pacific Fishery Management Council, Portland, OR.

Helser, T. E., M. W. Dorn, M. W. Saunders, C. D. Wilson, M. A. Guttormsen, K. Cooke, and M. E. Wilkins. 2002b. Stock assessment of Pacific whiting in U.S. and Canadian waters in 2001. *In* Status of the Pacific Coast groundfish fishery through 2002 (SAFE Report), volume I. Pacific Fishery Management Council, Portland, OR.

Hilborn, R., J. L. Valero, and M. Maunder. 2001. Status of the sablefish resource off the continental U.S. Pacific coast in 2001. *In* Appendix to status of the Pacific coast groundfish fishery through 2001 and recommended biological catches for 2002 (SAFE Report), volume I. Pacific Fishery Management Council, Portland, OR.

Hosie, M. J. 1976. The rex sole. Oregon Dept. Fish and Wildlife, Newport, OR, February 1976, Informational Report 76-2. 5p.

Hosie, M. J., and H. E. Horton. 1977. Biology of the rex sole, *Glyptochepalus zachirus*, in waters off Oregon. Fish. Bull. 75:51-60.

Hubbs, C. L., and A. N. Wick. 1951. Toxicity of the roe of the cabezon *Scorpaenichthys marmoratus*. Calif. Dept. Fish and Game 37:195-196.

Ianelli, J. N., M. Wilkins, and S. Harley. 2000. Status and future prospects for the Pacific Ocean perch resource in waters off Washington and Oregon as assessed in 2000. *In* Appendix to Status of the Pacific coast groundfish fishery through 2000 and recommended acceptable biological catches for 2001 (SAFE report). Pacific Fishery Management Council, Portland, OR.

IPHC (International Pacific Halibut Commission). 1998. The Pacific Halibut: Biology, Fishery, and Management. International Pacific Halibut Commission Tech. Rep. 40. 63p.

Jacobson, L. D., and J. R. Hunter. 1993. Bathymetric demography and management of Dover sole. N. Amer. J. Fish. Manag. 13:405-420.

Jacobson, L. D., and R. D. Vetter. 1996. Bathymetric demography and niche separation of thornyhead rockfish: *Sebastolobus alascanus* and *Sebastolobus altivelis*. Can. J. Fish. Aquat. Sci. 53:600-609.

Jagielo, T. 1994. Assessment of lingcod (*Ophiodon elongatus*) in the area north of Cape Falcon (45 N.) and south of 49 N. in 1994. *In* Status of the Pacific Coast groundfish fishery through 1994 and recommended acceptable biological catches for 1995 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Jagielo, T., P. Adams, M. Peoples, S. Rosenfield, K. R. Silberberg, and T. E. Laidig. 1997. Assessment of lingcod in 1997. *In* Appendix to status of the Pacific coast groundfish fishery through 1997 and recommended acceptable biological catches for 1998 (SAFE Report). Pacific Fishery Mangement Council, Portland, OR.

Jagielo, T., and J. Hastie. 2001. Updated rebuilding analysis for lingcod. Unpublished report prepared for the Pacific Fishery Management Council. Pacific Fishery Management Council, Portland, OR.

Jagielo, T., D. Wilson-Vandenberg, J. Sneva, S. Rosenfield, and F. Wallace. 2000. Assessment of lingcod (*Ophiodon elongatus*) for the Pacific Fishery Management Council in 2000. *In* Appendix to status of the Pacific coast groundfish fishery through 2000 and recommended acceptable biological catches for 2001 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Jow, T., and J. J. Geibel. 1985. Progress report on the status of English sole in California Conception, Monterey, and Eureka areas. *In* Appendix 8 to Status of the Pacific coast groundfish fishery through 1985 and recommended acceptable biological catches for 1986 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Karpov, K. A., D. P. Albin, and W. H. V. Buskirk. 1995. Lingcod. *In* The marine recreational fishery in Northern and Central California. Accessed: September 4, 2001 at www.recfin.org/pub/bull176/lingcod/html.

Ketchen, K. S., and C. R. Forrester. 1966. Population dynamics of petrale sole, *Eopsetta jordani*, in waters off western Canada. Fish. Res. Bd. Can. Bull. No. 153:195.

King, J. R., G. A. McFarlane, and R. J. Beamish. 2000. Decadal-scale patterns in the relative year class success of sablefish (*Anoplopoma fimbria*). Fish. Oceanogr. 9:62-70.

Kline, D. E. 1996. Radiochemical age verification for two deep-sea rockfishes *Sebastolobus altivelis* and *S. alascanus*. Master of Science. Moss Landing Marine Laboratorties, San Jose State University, San Jose, CA. 116p.

Kramer, D. E., W. H. Barss, B. C. Paust, and B. E. Bracken 1995. Guide to northeast Pacific flatfishes: families Bothidae, Cynoglossidae, and Pleuronectidae. Alaska Sea Grant College Program. Alaska Development Foundation, Anchorage, AK, Marine Advisory Bull. 47. 104p.

Kramer, S. H., J. S. Sunada, and S. P. Wertz. 2001. California Halibut. Pages 195-197 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's Living Marine Resources: A Status Report. Cal. Dept. of Fish and Game.

Kravitz, M. J., W. G. Pearcy, and M. P. Guin. 1976. Food of five species of co-occuring flatfishes on Oregon's continental shelf. Fish. Bull. 74:984-990.

Krieger, K. J. 1993. Distribution and abundance of rockfish determined from a submersible and by bottom trawling. Fish. Bull. 91(1):87-96.

Kruse, G. H., and A. V. Tyler. 1983. Simulation of temperature and upwelling effects on the English sole (*Paroophrys vetulus*) spawning season. Can. J. Fish. Aquat. Sci. 40:230-237.

Krygier, E. E., and W. G. Pearcy. 1986. The role of estuarine and offshore nursery areas for young English sole, *Parophrys vetulus* Girard, off Oregon. Fish. Bull. 84:119-132.

Kucas, S. T., and T. J. Hassler 1986. Species Profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)--California halibut. U.S. Fish Widl. Serv., Biol. Rep. 82 (11.33). U.S. Army Corps of Engineers, TR EL-82-4 8p..

Larson, M. L. 2001. Spot Prawn. Pages 121-123 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's Living Marine Resources: A Status Report. Calif. Dept. Fish and Game.

Larson, R. J., and D. A. Wilson-Vandenberg. 2001. Other Nearshore Rockfishes. Pages 185-188 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Lassuy, D. R. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest)--Pacific herring. U.S. Fish Wildl. Serv., 82(11.126). U.S. Army Corps of Engineers, TR-EL-82-4. 18p.

Lauth, R. R. 1987. Seasonal spawning cycle, spawning frequency and batch fecundity of the cabezon, *Scorpaenichthys marmoratus*, in Puget Sound, Washington. M.S. University of Washington, Seattle, WA.

Lauth, R. R. 1988. Seasonal spawning cycle, spawning frequency and batch fecundity of the cabezon, *Scorpaenichthys marmoratus*, in Puget Sound, Washington. Fish. Bull. 87:145-154.

Lea, R. N. 2001. Copper Rockfish. Pages 173-174 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Lee, T. 1993. Summary of cetacean survey data collected between the years of 1974 and 1985. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-SWFSC-181. 184p.

Leet, W. S., C. M. DeWees, and C. W. Haugen 1992. California's living marine resources and their utilization. California Sea Grant Extension, Davis, CA, Publication UCSGEP-92-12.

Lenarz, W. H. 1993. An initial examination of the status of the darkblotched rockfish fishery off the coasts of California, Oregon, and Washington. *In* Appendix to status of the Pacific coast groundfish fishery through 1993 and recommended acceptable biological catches for 1994. Pacific Fishery Management Council, Portland, OR.

Lenarz, W. H. 2001. Shortbelly Rockfish. Pages 380-381 *in* W. S. Leet, D. E. Pearson, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Lenarz, W. H., D. A. VenTresca, W. M. Graham, F. B. Schwing, and F. Chavez. 1995. Explorations of *el niño* events and associated biological population dynamics off central California. Calif. Coop. Oceanic Fish. Invest. Rep. (37):106-119.

Leos, R. 1991. Sanddabs. W. S. Leet, C. M. Dewees, and C. W. Haugen, editors. *In* California's living marine resources and their utilization. Calif. Dept. Fish and Game.

Love, M. 1991. Probably more than you want to know about the fishes of the Pacific coast. Really Big Press, Santa Barbara, CA. 215p.

Love, M. 1996. Probably more than you want to know about the fishes of the Pacific coast. Second Edition. Really Big Press, Santa Barbara, CA. 381p.

Love, M. 2001. Olive Rockfish. Pages 168-169 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Love, M., and J. Butler. 2001. Blackgill Rockfish. Pages 378-37 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Love, M., and D. Watters. 2001. Bank Rockfish. Pages 378-379 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Love, M. S., M. Yoklavich, and L. Thorsteinson. 2002. The Rockfishes of the Northeast Pacific. Univ. of Calif. Press, Berkeley. 405p.

Low, L. L., G. K. Tanonaka, and H. H. Shippen 1976. Sablefish of the northeastern Pacific Ocean and Bering Sea. U.S. Department of Commerce, National Marine Fisheries Service, Northwest Fisheries Center, October 1976. Processed Rep. 115p.

Lowry, N. 2002. University of Washington, Seattle. Personal Communication: C. C. Schmitt, Newport, OR.

MacCall, A. D. 1996. Patterns of low-frequency variability in fish populations of the California Current. Calif. Coop. Oceanic Fish. Invest. Rep. (37):100-110.

MacCall, A. D. 2002. Status of bocaccio off California in 2002. Santa Cruz, CA. Unpublished manuscript. 4p.

MacCall, A. D., R. A. Klingbeil, and R. D. Methot. 1985. Recent increased abundance and potential productivity of Pacific mackerel (*Scomber japonicus*). Calif. Coop. Oceanic Fish. Invest. Rep. 26:119-129.

MacCall, A. D., S. Ralston, D. Pearson, and E. Williams. 1999. Status of bocaccio off California in 1999 and outlook for the next millennium. *In* Appendix to status of the Pacific coast groundfish fishery through 1999 and recommended acceptable biological catches for 2000 (SAFE report). Pacific Fishery Management Council, Portland, OR.

Mackas, D. L., R. E. Thomson, and M. Galbraith. 2001. Changes in zooplankton community of the British Columbia continental margin, 1985-1999, and their covariation with oceanographic conditions. Can. J. Fish. Aquat. Sci. 58(4):685-702.

Maher, W. J. 1984. Skuas and Jaegers. Pages 120-129 *in* D. Haley, editor. Seabirds of Eastern North Pacific and Arctic Waters. Pacific Search Press, Seattle.

Maloney, N. E., and J. Heifetz 1997. Movements of tagged sablefish, *Anoplopoma fimbria,* released in the eastern Gulf of Alaska. U.S. Department of Commerce, NOAA, Seattle, WA, NOAA Technical Report NMFS 130.

Mangels, K. F., and T. Gerrodette. 1994. Report of cetacean sightings during a marine mammal survey in the eastern Pacific Ocean and Gulf of California aboard the NOAA ships McARTHUR and DAVID STARR JORDAN July 28 - November 6, 1993. NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFSC-211.

Manuwal, D. A. 1984. Alcids - dovekie, murres, guillemots, murrelets, auklets, and puffins. Pages 168-187 *in* D. Haley, editor. Seabirds of Eastern North Pacific and Arctic Waters. Pacific Search Press, Seattle.

Mason, J., and T. Bishop. 2001. Jack Mackerel. Pages 309-311 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's Living Marine Resources: A Status Report. Cal. Dept. of Fish and Game.

Mason, J. E., R. J. Beamish, and G. A. McFarlane. 1983. Sexual maturity, fecundity, spawning, and early life history of sablefish (*Anoplopoma fimbria*). Can. J. Fish. Aqua. Sci. 40:2126-2134.

McCrae, J. 1994a. Oregon Developmental Species: Spot Prawn. Oregon Dept. Fish and Wildlife. Accessed: August 26, 2002 at www.hmsc.orst.edu/odfw/devfish/sp/prawn.html.

McCrae, J. 1994b. Oregon Developmental Species: Pacific herring. Oregon Dept. Fish and Wildlife. Accessed: August 26, 2002 at www.hmsc.orst.edu/odfw/devfish/sp/herring.html.

McCrae, J. 1994c. Oregon Developmental Species: Smelt. Oregon Dept. Fish and Wildlife. Accessed: August 26, 2002 at www.hmsc.orst.edu/odfw/devfish/sp.smelt.html.

McFarlane, G. A., and R. J. Beamish. 1990. Effect of an external tag on growth of sablefish (*Anoplopoma fimbria*), and consequences to mortality and age at maturity. Can. J. Fish. Aquat. Sci. 47:1551-1557.

Methot, D. 1994. Assessment of the west coast sablefish stock in 1992. *In* Appendix B to status of the Pacific coast groundfish fishery through 1994 and recommended acceptable biological catches for 1995 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Methot, D. 1995. Geographic patterns in growth and maturity of female sablefish off the U.S. west coast. NOAA, NMFS, Northwest Fisheries Science Center, Seattle, WA. 42p.

Methot, R., and K. Piner. 2002. Status of the canary rockfish resource off California, Oregon and Washington in 2001. NOAA, NMFS, Northwest Fisheries Science Center, Seattle, WA. Unpublished manuscript. 25p.

Miller, D. J., and R. N. Lea. 1972. Guide to the coastal marine fishes of California. Calif. Dept. Fish and Game Bull. 147:249.

Mormorunni, C. L. 2001. The Spot Prawn Fishery: A Status Report. Asia Pacific Environmental Exchange, Seattle, WA.

Moser, H. G., R. L. Charter, P. E. Smith, D. A. Ambrose, S. R. Charter, C. A. Meyer, E. M. Sandknop, and W. Watson. 1993. Distributional atlas of fish larvae and eggs in the California Current region: Taxa with 1000 or more total larvae, 1951-1984. CalCOFI Atlas 31:233p.

NatureServe Explorer. 2002. An Online Encyclopedia of Life NatureServe Explorer. Accessed: February 7, 2003 at www.natureserve.org/explorer.

Nichol, D. G. 1990. Life History Examination of Darkblotched Rockfish (*Sebastes crameri*) off the Oregon Coast. Master of Science. Oregon State University, Corvallis, OR. 124p.

NMFS (National Marine Fisheries Service) Stock Assessment Team (Northwest Fisheries Science Center Fishery Resource Analysis and Monitoring Division). 1999b. Status of the canary rockfish resource off Oregon and Washington in 1999. Pacific Fishery Management Council, Portland, OR.

NMFS 2001. Programmatic supplemental environmental impact statement for Alaska groundfish fisheries. Public Review Draft. National Marine Fisheries Service, Alaska Region, Juneau, Alaska.

NMFS 2002. Draft amendment 17 to the Pacific coast groundfish fishery management plan (multi-year management and specifications and management measures process). Pacific Fishery Management Council, Portland, Oregon, June, 2002.

NMFS, and Ocean Trust (Northwest Fisheries Science Center Fishery Resource Analysis and Monitoring Division and Ocean Trust Stock Assessment Teams). 1998. Status of the shortspine thornyhead resource of the U.S. Pacific Coast in 1998: Stock Assessment Teams Summary Report: Stock assessment and fishery evaluation. Pacific Fishery Management Council, Portland, OR.

NOAA (National Oceanographic and Atmospheric Administration). 1990. West coast of North America coastal and ocean zones strategic assessment: Data atlas. Invertebrate and Fish Volume. OMA/NOS, Ocean Assessments Division, Strategic Assessment Branch, Invertebrate and Fish Volume.

Ono, D. 2001. Calico Rockfish. Pages 179-180 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Osorio, D. A., and R. Klingbeil. 2001. Quillback Rockfish. Pages 179-180 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

PacFIN (Pacific Fishery Information Network). 2002. All W-O-C species rpt: 1998 commercial landed catch: metric-tons, revenue, and price-per-pound. Pacific States Marine Fisheries Commission, Gladstone, OR, Report 307.

Palsson, W. A. 1990. Pacific cod in Puget Sound and adjacent waters: Biology and stock assessment. Wash. Dept. Fish. and Wildlife, Tech. Rep. 112. 137p.

Parsons, C. 1986. Dangerous marine animals of the Pacific coast. Helm Publishing, San Luis Obispo, CA. 96p.

Pauley, G. B., D. A. Armstrong, and T. W. Huen 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest)--

Dungeness crab. U.S. Fish Wildl. Serv., 82(11.63). U.S. Army Corps of Engineers, TR EL-82-4. 20p.

Pearcy, W. G. 1978. Distribution and abundance of small flatfishes and other demersal fishes in a region of diverse sediments and bathymetry off Oregon. Fish. Bull. 76:629-640.

Pearcy, W. G., and D. Hancock. 1978. Feeding habits of Dover sole, *Microstomus pacificus*; rex sole, *Glyptocephalus zachirus*, slender sole, *Lyopsetta exilis*; and Pacific sanddab, *Citharichthys sordidus*; in a region of diverse sediments and bathymetry off Oregon. Fish . Bull. 76:641-651.

Pearcy, W. G., M. J. Hosie, and S. L. Richardson. 1977. Distribution and duration of pelagic life of Dover sole, *Microstomus pacificus*; rex sole, *Glyptocephalus zachirus;* and petrale sole *Eopsetta jordani*, in waters off Oregon. Fish. Bull. 75:175-183.

Pearson, D. E., and J. E. Hightower 1991. Spatial and temporal variability in growth of widow rockfish (Sebastes entomelas). NOAA, NMFS. NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-240. 62p.

Pearson, D. E., J. E. Hightower, and J. T. H. Chan. 1991. Age, growth, and potential yield for shortbelly rockfish *Sebastes jordani*. Fish. Bull. (89):403-409.

Perrin, W. F., M. D. Scott, G. J. Walker and V. L. Cass. 1985. Review of geographical stocks of tropical dolphins (*Stenella* spp. and *Delphinus delphis*) in the eastern Pacific. NOAA Tech. Rep. NMFS 28. Available from NOAA Fisheries, Southwest Fisheries Science Center, La Jolla, California. 28 p.

PFMC (Pacific Fishery Management Council).1998. Amendment 8 to The Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council, Portland, OR, December 1998.

PFMC 1999a. Identification and description of Essential Fish Habitat, adverse impacts, and recommended conservation measures for salmon. Appendix A. Pacific Fishery Management Council, Portland, OR, August 1999.

PFMC 1999b. Status of the Pacific Coast groundfish fishery through 1999 and acceptable biological catches for 2000 (SAFE Report). Pacific Fishery Management Council, Portland, Oregon.

PFMC 2000. Status of the Pacific Coast Groundfish Fishery Through 2000 and Acceptable Biological Catches for 2001 (SAFE Report). Pacific Fishery Management Council, Portland, Oregon.

PFMC 2001. Amendment 9 to The Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council, Portland, OR, March 2001.

PFMC 2002a. Status of the Pacific Coast groundfish fishery Through 2001 and acceptable biological catches for 2002 (SAFE Report). Pacific Fishery Mangement Council, Portland, Oregon.

PFMC 2002b. Draft environmental impact statement for the proposed groundfish acceptable biological catch and optimum yield specifications and management measures: 2003 Pacific Coast groundfish fishery, Portland, Oregon.

PFMC 2002c. Status of the Pacific Coast groundfishfishery through 2002 and acceptable biological catches for 2003 (SAFE Report). Pacific Fishery Mangement Council, Portland, Oregon.

PFMC 2002d. Draft lingcod rebuilding plan. Pacific Fishery Mangement Council, Portland, Oregon.

Phillips, J. B., and S. Imamura. 1954. The sablefish fishery of California. Pacific Marine Fisheries Commission Bulletin 3:5-38.

Pillsbury, J. B. 1957. Avoidance of poisonous eggs of the marine fish *Scorpaenichthys marmoratus* by predators. Copeia 1957:251-252.

Piner, K., and D. Methot 2001. Stock status of shortspine thornyhead off the Pacific West Coast of the United States 2001. *In* Appendix to status of the Pacific coast groundfish fishery through 2001 and recommended acceptable biological catches for 2002 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Piner, K., M. Schirripa, T. Builder, J. Rogers, and R. Methot. 2000. Bank rockfish (Sebastes rufus) stock assessment for Eureka, Monterey and Conception INPFC Areas north of Point Conception, Calfiornia. *In* Appendix to status of the Pacific coast groundfish fishery through 2000 and recommended acceptable biological catches for 2001 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Porter, P. 1964. Notes on fecundity, spawning, and early life history of petrale sole (*Eopsetta jordani*), with descriptions of flatfish larvae collected in the Pacific ocean off Humboldt Bay, California. Master of Science. Humboldt State College, Arcata, CA. 98p.

Ralston, S. 2001. Yellowtail Rockfish. Pages 370-371 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Ralston, S., J. R. Bence, M. B. Eldridge, and W. H. Lenarz. *In Press*. An approach to estimating rockfish biomass based on larval production with application to Sebastes jordani.

Ralston, S., and W. H. Lenarz. 2001. Widow Rockfish. Pages 370-371 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Ralston, S., and K. T. Oda. 2001. Chilipepper. Pages 366-367 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Ralston, S., D. E. Pearson, and J. A. Reynolds. 1998. Status of the chilipepper rockfish stock in 1998. *In* Appendix to status of the Pacific coast groundfish fishery through 1998 and recommended acceptable biological catches for 1999 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Reilly, P. 2001a. Black Rockfish. Pages 162-164 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Reilly, P. 2001b. Blue Rockfish. Pages 165-167 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Rickey, M. H. 1993. Status of the coastal arrowtooth flounder resource in 1993. *In* Appendix I to status of the Pacific coast groundfish fishery through 1993 and recommended acceptable biological catches for 1994 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Rogers, J. B., T. L. Builder, P. R. Crone, J. Brodziak, R. D. Methot, R. J. Conser, and R. Lauth. 1998. Status of the shortspine thornyhead (*Sebastolobus alascanus*) resource in 1998. *In* Appendix to Status of the Pacific coast groundfish fishery through 1998 and recommended acceptable biological catches for 1999 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Rogers, J. B., L. J. Jacobson, R. Lauth, J. N. Ianelli, and M. Wilkins. 1997. Status of the thornyhead (*Sebastolobus sp.*) resource in 1997. *In* Appendix to status of the Pacific coast groundfish fishery through 1997 and recommended acceptable biological catches for 1998 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Rogers, J. B., R. D. Methot, T. L. Builder, and K. Piner. 2000. Status of the darkblotched rockfish (Sebastes crameri) resource in 2000. *In* Appendix to status of the Pacific coast groundfish fishery through 2000 and recommended acceptable biological catches for 2001 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Sakuma, K. M., and R. J. Larson. 1995. Distribution and pelagic metamorphic-stage sanddabs, *Citharichthys sordidus* and *Citharichthys stigmaeus* within areas of upwelling off central California. Fish. Bull. 93:516-529.

Sampson, D. B., and Y. W. Lee. 1999. An assessment of the stocks of petrale sole off Washington, Oregon, and Northern California in 1998. *In* Appendix to Status of the Pacific coast groundfish fishery through 1999 and recommended acceptable biological catches for 2000 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Sampson, D. B., and E. M. Stewart. 1993. An assessment of the English sole stock off Oregon and Washington. *In* Appendix H-1 to status of the Pacific coast groundfish fishery through 1993 and recommended acceptable biological catches for 1994 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Sampson, D. B., and E. M. Stewart. 1994. Status of the canary rockfish resource off Oregon and Washington in 1994. *In* Appendix to status of the Pacific coast groundfish fishery through 1994 and recommended acceptable biological catches for 1995 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Sampson, D. B., and C. Wood 2002. Stock status of Dover sole off the U.S. West Coast in 2000. *In* Appendix to status of the Pacific coast groundfish fishery through 2001 and recommended acceptable biological catches for 2002 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Schirripa, M. 2002. Status of the sablefish resource off the continental U.S. Pacific Coast in 2002. *In* Appendix to status of the Pacific Coast groundfish fishery through 2002 (SAFE Report), volume I. Pacific Fishery Management Council, Portland, OR.

Schirripa, M. J., and R. Methot. 2001. Status of the sablefish resource off the continental U.S. Pacific coast in 2001. *In* Appendix to status of the Pacific coast groundfish fishery through 2001 and recommended biological catches for 2002 (SAFE Report), volume I. Pacific Fishery Management Council, Portland, OR.

Shallenberger, R. J. 1984. Fulmars, shearwaters, and gadfly petrels. Pages 42-57 *in* D. Haley, editor. Seabirds of Eastern North Pacific and Arctic Waters. Pacific Search Press, Seattle.

Shaw, F. R. 1984. Data report: results of sablefish tagging in waters off the coast of Washington, Oregon, and California, 1979-1983. U. S. Department of Commerce, NOAA Technical Memorandum NMFS F/NWC-69. 79p.

Shimada, A. M., and D. K. Kimura. 1994. Seasonal movements of Pacific cod, *Gadus macrocephalus*, in the eastern Bering Sea and adjacent waters based on tag-recapture data. Fish. Res. 19:68-77.

Smith, K. L., and N. O. Brown. 1983. Oxygen consumption of pelagic juveniles and demersal adults of the deep-sea fish *Sebastolobus altivelis*, measured by depth. Mar. Biol. 76:325-332.

Soutar, A., and J. D. Isaacs. 1974. Abundance of pelagic fish during the 19th and 20th centuries as recorded in anaerobic sediment off the Californias. Fish. Bull. 72:257-273.

Sowls, A. L., A. R. DeGrange, J. W. Nelson, and G. S. Lester 1980. Catalog of California Seabird Colonies. U.S. Department of the Interior, Fish and Wildlife Service, Biological Services Program, FWS/OBS 37/80. 371p.

Speich, S. M., and T. R. Wahl 1989. Catalog of Washington Seabird Colonies. U.S. Fish and Wildlife Service Biological Report, 88(6). 510p.

Spendelow, J. A., and S. R. Patton 1988. National Atlas of Coastal Waterbird Colonies in the Contiguous United States: 1976-82. U.S. Fish and Wildlife Service Biological Report, 88(5). 326p.

Springer, A. M., A. Y. Kondratyev, H. Ogi, Y. V. Shibaev, and G. B. van Vliet. 1993. Status, ecology, and conservation of *Synthliboramphus* murrelets and auklets. Pages 187-201 *in* K. Vermeer, K.T. Briggs, K.H. Morgan and D. Siegel-Causey, editors. The Status, Ecology, and Conservation of Marine Birds in the North Pacific. Can. Wildl. Spec. Publ., Ottawa.

Stull, J. K., and C. Tang. 1996. Demersal fish trawls off Palos Verdes, southern California, 1973-1993. CalCOFI Rep. 37:211-240.

Sunada, J. S., J. B. Richards, and L. M. Laughlin. 2001. Ridgeback Prawn. Pages 124-126 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's Living Marine Resources: A Status Report. Calif. Dept. Fish and Game.

Sweetnam, D. A., R. D. Baxter, and P. B. Moyle. 2001. True Smelts. Pages 472-479 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's Living Marine Resources: A Status Report. Calif. Dept. Fish and Game.

SWFSC (National Marine Fisheries Service, Southwest Fisheries Science Center). 2002.. Shark Research. NOAA NMFS Southwest Fisheries Science Center Fisheries Resources Division. Accessed: November 16, 2002 at www.swfsc.nmfs.noaa.gov/frd/HMS/Large%20Pelagics/Sharks/species.

Tagart, J. V. 1991. Population dynamics of yellowtail rockfish (*Sebastes flavidus*) stocks in the northern California to Vancouver Island region. Ph.D. Dissertation. University of Washington, Seattle, Washington. 323p.

Tagart, J. V., J. N. Ianelli, J. Hoffmann, and F. R. Wallace. 1997. Status of the yellowtail rockfish resource in 1997. *In* Appendix to status of the Pacific coast groundfish fishery through 1997 and recommended acceptable biological catches for 1998 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Tagart, J. V., F. R. Wallace, and J. N. Ianelli. 2000. Status of the yellowtail rockfish resource in 2000. *In* Appendix to status of the Pacific coast groundfish fishery through 2000 and recommended acceptable biological catches for 2001 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Thomas, D. H., and A. D. MacCall. 2001. Bocaccio. Pages 162-164 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Trumble, R. J., G. St.-Pierre, and I. R. McGregor 1991. Evaluation of Pacific Halibut Management for Regulatory Area 2A Pages 1-38 *in* I. Review of the Pacific Halibut Fishery in Area 2A. International Pacific Halibut Commission, Sci. Rep. 74.

Tyler, W. B., K. T. Briggs, D. B. Lewis, and R. G. Ford. 1993. Seabird distribution and abundance in relation to oceanographic processes in the California current system. Pages 48-60 *in* K. Vermeer, K.T. Briggs, K.H. Morgan and D. Siegel-Causey, editors. The Status, Ecology, and Conservation of Marine Birds in the North Pacific. Can. Wildl. Serv. Spec. Publ., Ottawa.

Vermeer, K., D. B. Irons, E. Velarde, and Y. Watanuki. 1993. Status, conservation, and management of nesting *Larus* gulls in the North Pacific. Pages 131-139. *in* K. Vermeer, K.T. Briggs, K.H. Morgan and D. Siegel-Causey, editors. The Status, Ecology, and Conservation of Marine Birds in the North Pacific. Can. Wildl. Serv. Spec. Publ., Ottawa.

Vetter, R. D., E. A. Lynn, M. Garza, and A. S. Costa. 1994. Depth zonation and metabolic adaptations in Dover sole and other deep-living flatfishes: Factors that affect the sole. Fish. Bull. 120:145-159.

Vincent-Lang, D. 1994. Lingcod *In:* ADF&G Wildlife Notebook Series. Alaska Dept. Fish and Game. Accessed: September 4, 2001 at www.state.ak...H.GAME/notebook/fish/lingcod.htm.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12. 93 p.

Wakefield, W. W., and K. L. Smith. 1990. Ontogenetic vertical migration in *Sebastolobus altivelis* as a mechanism for transport of particulate organic matter at continental slope depths. Limnol. Oceanogr. 35:1314-1328.

Wallace, F. R. 2001. Status of the yelloweye rockfish resource. Wash. Dept. Fish and Wildlife. Unpublished manuscript. 8p.

Wallace, F. R., A. Hoffmann, and J. V. Tagart. 1999. Status of the black rockfish resource in 1999. *In* Appendix to Status of the Pacific coast groundfish fishery through 1999 and recommended acceptable biological catches for 2000 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Wang, J. C. S. 1986. Fishes of the Sacramento-San Joaquin Estuary and Adjacent Waters, California: A Guide to the Early Life Histories. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, Tech. Rep. 9 (FS/B10-4ATR 86-9).

Watters, D. L., K. T. Oda, and J. Mello. 2001. Pacific Herring. Pages 456-459 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's Living Marine Resources: A Status Report. Calif. Dept. Fish and Game.

WDFW (Washington Department of Fish and Wildlife). 2001. WDFW Coastal Dungeness Crab Draft Even Flow Harvest Management Plan. Wash. Dept.Fish and Wildlife, Olympia, WA, August 2001.

WDFW 2002. 1999-01 Biennial Report. Wash. Dept. Fish and Wildlife, Olympia, WA.

Weeks, H. 2002. Biological synopsis of nearshore species: cabezon. Appendix B to Attachment 3: An interim management plan for Oregon's nearshore commercial fisheries. Pages 40-42 *in* Oregon Fish and Wildlife Commission Exhibit H. Oregon Dept. Fish and Wildlife, Newport, Oregon, October 11, 2002.

Williams, E. H., and P. B. Adams. 2001. Canary Rockfish. Pages 175-176 *in* W. S. Leet, C. M. Dewees, R. Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. Calif. Dept. Fish and Game.

Williams, E. H., A. D. MacCall, S. V. Ralston, and D. E. Pearson. 2000. Status of the widow rockfish resource in Y2K. *In* Appendix to status of the Pacific coast groundfish fishery through 2000 and recommended acceptable biological catches for 2001 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Williams, E. H., S. Ralston, A. D.MacCall, D. Woodbury, and D. E. Pearson. 1999. Stock assessment of the canary rockfish resource in the waters off southern Oregon and California in 1999. *In* Appendix to status of the Pacific coast groundfish fishery through 1999 and recommended acceptable biological catches for 2000 (SAFE Report). Pacific Fishery Management Council, Portland, OR.

Appendix C: Treaty Indian Fishing Rights

Legal Background

Treaties between the United States and numerous Pacific Northwest Indian tribes reserve to these tribes the right of taking fish at usual and accustomed grounds and stations ("u & a grounds") in common with all citizens of the United States. See U.S. v. Washington, 384 F. Supp. 312, 349-350 (W.D. Wash. 1974).

The National Marine Fisheries Service (NMFS) recognizes four tribes as having u & a grounds in the marine areas managed by the Groundfish FMP: the Makah, Hoh, and Quileute tribes, and the Quinault Indian Nation. The Makah Tribe is a party to the Treaty of Neah Bay, Jan. 31, 1855, 12 Stat. 939. See 384 F. Supp. at 349, 363. The Hoh and Quileute tribes and the Quinault Indian Nation are successors in interest to tribes that signed the Treaty with the Quinault, et al. (Treaty of Olympia), July 1, 1855, 12 Stat. 971. See 384 F. Supp. at 349, 359 (Hoh), 371 (Quileute), 374 (Quinault). The tribes' u & a grounds do not vary by species of fish. U.S. v. Washington, 157 F. 3d 630, 645 (9th Cir. 1998).

The treaty fishing right is generally described as the opportunity to take a fair share of the fish, which is interpreted as up to 50 percent of the harvestable surplus of fish that pass through the tribes' u & a grounds. Washington v. Washington State Commercial Passenger Fishing Vessel Association, 443 U.S. 658, 685-687 (1979) (salmon); U.S. v. Washington, 459 F. Supp. 1020, 1065 (1978) (herring); Makah v. Brown, No. C85-160R, and U.S. v. Washington, Civil No. 9213 - Phase I, Subproceeding No. 92-1 (W.D. Wash., Order on Five Motions Relating to Treaty Halibut Fishing, at 6, Dec. 29, 1993) (halibut); U.S. v. Washington, 873 F. Supp. 1422, 1445 and n. 30 (W.D. Wash. 1994), aff'd in part and rev'd in part, 157 F. 3d 630, 651-652 (9th Cir. 1998), cert. denied, 119 S.Ct. 1376 (1999) (shellfish); U.S. v. Washington, Subproceeding 96-2 (Order Granting Makah's Motion for Summary Judgment, etc. at 4, November 5, 1996) (Pacific whiting). The court applied the conservation necessity principle to federal determinations of harvestable surplus in Makah v. Brown, No. C85-160R/ United States v. Washington, Civil No. 9213 - Phase I, Subproceeding No. 92-1, Order on Five Motions Relating to Treaty Halibut Fishing, at 6-7, (W.D. Wash. Dec. 29, 1993); Midwater Trawlers Co-op. v. Department of Commerce, 282 F.3d 710, 718-719 (9th Cir. 2002).

The treaty right was originally adjudicated with respect to salmon and steelhead. However, it is now recognized as applying to all species of fish and shellfish within the tribes' u & a grounds. U.S. v. Washington, 873 F.Supp. 1422, 1430, aff'd 157 F. 3d 630, 644-645 (9th Cir. 1998), cert. denied, 119 S.Ct. 1376; Midwater Trawlers Co-op. v. Department of Commerce, 282 F.3d 710, 717 (9th Cir. 2002) ["The term 'fish' as used in the Stevens Treaties encompassed all species of fish, without exclusion and without requiring specific proof. (citations omitted)"]

NMFS recognizes the areas set forth in the regulations cited below as marine u & a grounds of the four Washington coastal tribes. The Makah u & a grounds were adjudicated in U.S. v. Washington, 626 F.Supp. 1405, 1466 (W.D. Wash. 1985), aff'd 730 F.2d 1314 (9th Cir. 1984); see also Makah Indian Tribe v. Verity, 910 F.2d 555, 556 (9th Cir. 1990); Midwater Trawlers Co-op. v. Department of Commerce, 282 F.3d 710, 718 (9th Cir. 2002). The u & a grounds of the Quileute, Hoh, and Quinault tribes have been recognized administratively by NMFS. See, e.g., 67 Fed. Reg. 30616, 30624 (May 7, 2002) (u & a grounds for salmon); 50 C.F.R. 660.324(c) (u & a grounds for groundfish); 50 C.F.R. 300.64(i) (u & a grounds for halibut). The u & a grounds recognized by NMFS may be revised as ordered by a federal court.

Current Regulations

In 1994, the United States formally recognized that the four Washington coastal treaty Indian tribes (Makah, Quileute, Hoh, and Quinault) have treaty rights to fish for groundfish in the Pacific Ocean, and concluded that, in general terms, the quantification of those rights is 50 percent of the harvestable surplus of groundfish that pass through the tribes' usual and accustomed ocean fishing areas (described at 60 CFR 660.324). A federal regulation that specifically pertains to treaty Indian fisheries for groundfish was promulgated at 50 C.F.R. 660.324. This regulation acknowledges treaty Indian fishing rights, lists the tribes with fishing rights in the EEZ, describes the boundaries of the relevant tribes' u & a grounds in the Pacific Ocean, and establishes procedures for implementation of tribal rights.

Under the current groundfish regulations, a tribal allocation is subtracted from the species' OY before limited entry and open access allocations are derived. The tribal fisheries for sablefish, black rockfish, and whiting are separate fisheries, and are not governed by the limited entry or open access regulations or allocations. The tribes regulate these fisheries so as not to exceed their allocations.

In 2004, the tribal allocation for black rockfish taken for commercial purposes is 20,000 lb (9,072 kg) north of Cape Alava, WA (48 degrees 09'30" N. lat.) and 10,000 lb (4,536 kg) between Destruction Island, WA (47 degrees 40'00" N. lat.) and Leadbetter Point, WA (46degrees 38'10" N. lat.). The tribal sablefish allocation is 10 percent of the total catch OY north of Point Conception, CA (751 mt), less 3 percent for estimated discard mortality, or 728.5 mt.

In 1999 through 2004, the tribal whiting allocation has been based on a methodology originally proposed by the Makah Tribe in 1998. The methodology is an abundance-based sliding scale that determines the tribal allocation based on the level of the overall U.S. OY, up to a maximum 17.5 percent tribal harvest ceiling at OY levels below 145,000 mt. To date, only the Makah Tribe has conducted a whiting fishery.

The sliding scale methodology used to determine the treaty Indian share of Pacific whiting is the subject of ongoing litigation. In United States v. Washington, Subproceeding 96-2, the Court held that the sliding scale allocation methodology is consistent with the Magnuson-Stevens Act, and is the best available scientific method to determine the appropriate allocation of whiting to the tribes. United States v. Washington, 143 F.Supp.2d 1218 (W.D. Wash. 2001). This ruling was reaffirmed in July 2002, Midwater Trawlers Cooperative v. Daley, C96-1808R (W.D. Wash.) (Order Granting Defendants' Motion to Supplement Record, July 17, 2002), and again in April 2003, id., Order Granting Federal Defendants' and Makah's Motions for Summary Judgment and Denying Plaintiffs' Motions for Summary Judgment, April 15, 2003. The latter ruling has been appealed to the Ninth Circuit, but no decision has been rendered as yet. As of 2004, NMFS remains under a court order in Subproceeding 96-2 to continue use of the sliding scale methodology unless the Secretary of Commerce finds just cause for its alteration or abandonment, the parties agree to a permissible alternative, or further order issues from the Court. Therefore, NMFS is obliged to continue to use the methodology unless one of the events identified by the Court occurs.

For some species on which the tribes have a modest harvest, no specific allocation has been determined. Rather than try to reserve specific allocations for the tribes, NMFS has established trip limits recommended by the tribes and the Council to accommodate modest tribal fisheries. In 2004, tribal harvest limits are as follows. For lingcod, all tribal fisheries are restricted to 450 lb (204 kg) per day and 1,350 lb (612 kg) per week cumulative limits. Tribal fisheries will be managed with a 25-mt lingcod harvest guideline. For rockfish species, the 2004 tribal longline and trawl fisheries will operate under trip and cumulative limits. Tribal fisheries will operate under a 300-lb (136-kg) per trip limit each for canary rockfish, thornyheads, and the minor rockfish species groups (nearshore, shelf, and slope), and under a 100-lb (45-kg) trip limit for yelloweye rockfish. A 300-lb (136 kg) canary rockfish trip limit is expected to result in landings of 3.6 mt in 2004. A 300-lb (136-kg) thornyheads trip limit is expected to result in landings of 4.8 mt in 2004. Other rockfish limits are expected to result in the following landings levels: widow rockfish, 40 mt; yelloweye rockfish, 3.1 mt; yellowtail rockfish, 400 mt; minor nearshore rockfish, 2 mt; minor shelf rockfish excluding yelloweye, 4.5 mt; minor slope rockfish, 4 mt. Trace amounts (<1 mt) of POP and darkblotched rockfish may also be landed in tribal commercial fisheries.